Pain Unstuck The Role of Action and Motivation

Special Topic Series: Approach to Physical Activity in Pain: From Theory to the Lab, From Clinic to the Patient

Pain Unstuck

The Role of Action and Motivation

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Background: What is it that motivates our actions? As human beings, existing as part of complex societies, the actions we take are subject to multiple, often competing motives. Spanning non-conscious reflexes, cognitively derived choice as well as long- and short-term goals, our actions allow us to make sense of our environment. Pain disrupts action and hijacks our intentions. Whilst considered adaptive when temporary, pain that persists continues to interrupt and can threaten our ability to actively investigate a changing world.

Objective: This work is a narrative review.

Results: Drawing upon three complementary theoretical approaches to pain: an embodied framework, a motivational approach and the avoidance-endurance model, this review places the relationship between pain, motivation and action at its core, unpicking a dynamic process that can become stuck.

Conclusions: In taking a wide view of pain and action, we expose the nuances within drive to goal behaviour in the presence of pain. This has implications for the clinic, specifically in relation to assessing the multifactorial influences that shape action in pain. But it also seeks to go further, considering the broader environment in which we make decisions and the influence that other professionals, outside of typical healthcare roles, may play a part in the maintenance and resolution of pain.

Key Words: pain unstuck, embodied pain, motivation, cognitive bias, avoidance vs. endurance

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Action is imperative to our survival as embodied beings. Throughout development, we continually redefine our action possibilities, determined by our changing bodily limits and a changing environment. As we learn to walk, loss of balance and falling are commonplace, a process of trial and error that forms the basis for stable bipedal exploration.[1] Yet, later in development, beyond adolescence, despite the relative stability of shape and structure, the body remains dynamic.[2] Largely outside of conscious awareness, our bodies regulate in the face of perturbation, from temperature and pH to pressure and position.[3] It is only when these finely tuned, homeostatic processes are unable to rectify a perturbation that we are alerted to act.[4,5]

The experience of pain is one such alert that emerges from the prediction of the need for protective action, indicating the need to alter the current course of action.[6] This process is well rehearsed and broadly successful when the prediction of the need for protective action is short lived, for example, the need to restrict weight-bearing on a sprained ankle. The difficulty with such a honed, predictive system comes when the predicted need to protect persists.[7,8] In this case, from a rational appraisal of the key information from the body and the world, a prediction of threat rather than a prediction of safety has emerged.[9]

At stake, when the prediction of the need to protect and the experience of pain persists, is *the active pursuit of one's goals*, the attainment of which often necessitates the resolution of multiple competing demands. At its base, such goal conflict presents an explore-exploit dilemma, whereby continued action in the presence of pain (explore) is compared with protective action (exploit). Embedding our understanding of pain beyond the individual to encompass the world in which they interact is crucial to addressing ongoing goal conflict.

In the following sections, we draw upon 3 different but related approaches to pain. First, we explore theoretical advances within and outside of the pain field, outlining an embodied pain perspective, which demands an action-oriented approach to adequately describe the experience of pain. Second, the role of motivation in pain experience is critiqued in light of empirical evidence. Third, the interplay between control and motivation is considered from an action-oriented perspective, to help conceive clinically relevant experiences (eg, flare-up) and how this is relevant to treatment. The role of action, whether in the presence or absence of pain, unifies the 3 accounts that follow.

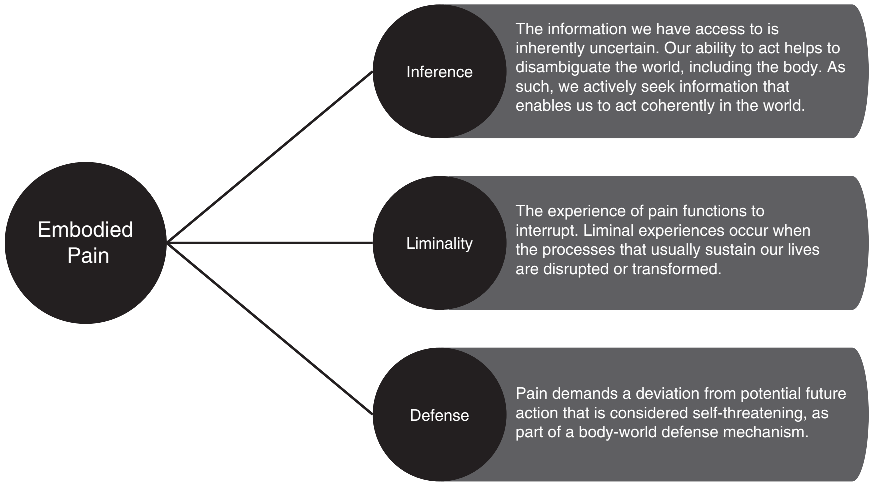

FIGURE 1. Embodied pain. Across all 3 components—inference, liminality, and defense—action is pervasive. It is a means to know our world better (active inference), to transition through disruption (acting in liminality), and to prevent self-threat (defensive action).

EMBODIED PAIN

An embodied approach to pain places the embodied and embedded nature of our experience at the fore of describing a rational and adaptive approach to pain. Here, embodied is defined by action, the premise that cognition extends beyond the brain so that an ever-changing body is at the core of how our experiences are shaped; this may be the unconscious workings of our immune system or the collaborative efforts made to avoid movement. Embedded refers to the situated interaction between the embodied being and the external environment, in both place (current context) and time (evolutionary context).[8]

The embodied pain perspective comprised 3 core components: inference, liminality, and defense, each of which considers the way in which we act in pain (Fig. 1).

An embodied pain approach provides a way to describe short-lasting pain, in which action associated with protection (avoid and defend) are short lived. Importantly, it provides the same framework to describe persistent pain, not as part of an irrational or maladaptive process, but rather an experience that emerges as part of a necessarily evolved system, which must continually deal with change and uncertainty.[10] For the majority of individuals, this predictive, yet fallible system works to promote flourishing interaction through temporary defensive action and redefinition of bodily boundaries, but for a significant minority, it results in diminished interaction though persistent defensive action.[11,12]

In this evolved and embodied system, pain can get stuck.[13] This stickiness represents an experience of an organism that is continually attempting to "best guess" the consequences of their actions, with an impoverished ability to access all the information.[14,15] Over time, just as we master the limits of our locomotion, we get better at predicting self-threatening action. Crucially, this process is shaped by the individual and their interactions with the world before, during, and subsequent to their experience of pain.[16]

This position challenges the traditional boundaries of acute and chronic pain, which tracks a timeline from pain initiation. Instead, it asserts that individuals may master the prediction of the need for protective action differently throughout their life, such that even in the traditional "acute" pain categorization, individuals are displaying a stickiness akin to a traditional "chronic" categorization. Persistent pain thus becomes an experience we recognize beyond a time-dependent, isolated experience, one which reflects more broadly the prior interactions of an individual that have served to hone a prediction of self-threatening action.

This embodied approach to pain sits within a broader framework in cognitive science, summarized as active inference.[17–19] As a framework that adds weight to the inferential nature of perception, active inference highlights the joint role of action and perception in shaping experience. That is, through action we are able to alter the way we sample the world, and through perception, we can alter the predictions we have of the world. Grounded in Bayesian inference, the experience is influenced by the precision associated with the information available, whether top-down predictions or bottom-up prediction errors. The greater the precision, the greater the influence on the experience.[20]

This is particularly relevant to pain, an experience that by its nature demands attention and altered action. For example, if an individual holds highly precise predictions of bodily threat, on the basis of previous experience and current evidence, this may promote exploit-based action (rest/withdrawal). One important consequence of this behavior is a reduction in explore-based action, which limits the amount of new information an individual is able to gain relating to the state of their body. In short, the prediction of bodily protection may go unchallenged. As a result, a stubborn prediction of protection from which pain emerges is established, representative of a narrowed body-world interaction: the experience of pain gets sticky.

The target of intervention is one of the redefinitions. This goes beyond the health care setting, indeed precursors, and embeds the clinic. We, as researchers, as clinicians, must start to consider a broader social context in which we learn the scope of our bodies; asking: how may we redefine the prediction that bodily protection is required? This speaks to the motivations and actions we execute throughout our lives; it relates to educators, architects, and governments that create the context from which action is derived.

MOTIVATIONAL PERSPECTIVE ON PAIN

The relationship between pain and context is placed at the center of understanding when adopting a motivational approach to pain. Within this perspective, pain is understood as a threatening and aversive experience, designed to demand *attention*[5,21,22] and *motivate* people to act upon its presence.[23,24] This often involves the interruption of ongoing activities to engage in pain mitigating behavior,[25] thus reducing the possibility of future encounters with similar situations that could potentially result in bodily harm.[26,27] Although for a long time neglected, the pain never occurs in isolation of context and ongoing goal pursuit.[23]

From this position, context is key for the understanding of the relationship between pain experience, pain interference, and distress,[23] biased cognitions (eg, attentional processing[28]), and future task engagement/avoidance behavior.[26] Crucially, this perspective sets pain within a context of multiple and often competing goals. To understand how people deal with these, often competing goals, we adopt explicitly a goal and self-regulation perspective, in which people attempt to gain control over their behavior, cognitions, or emotions to attain goals.[23,24] Within this perspective, pain can become the center of focus in 2 ways.

First, *pain may be unrelated to the pursued goal*, but because of its evolutionarily acquired alarm function, it demands attention and interferes with ongoing tasks or goal pursuit. A wealth of research has addressed this phenomenon, using primary task paradigms, consistently showing impairment of participants' task performance during the simultaneous experience of pain.[29–34] These findings received further support from research addressing the impact of naturally occurring forms of pain, such as recurrent pain (eg, menstrual pain[35]) or headaches[36] on ongoing tasks or goal pursuit.

Several characteristics have been found to affect the magnitude of task interference by pain. In particular, interference is increased when pain is more intense,[23,37] when the pain is novel,[30,38] when the pain is unpredictable[39,40] and when the pain is more threatening.[29] Supporting a motivational account, factors influencing goal pursuit have been found to influence the extent to which pain, unrelated to the pursued goal, may capture attention. Verhoeven et al[41], for example, manipulated the importance of a task aimed at distracting people from pain by making the task rewarding for one group (money for good performance) and not for the other groups. Results indicated that increased motivational relevance of the task reduced pain experience and the impact of pain on task performance in people who catastrophized about their pain. Later research further substantiated the idea that the importance of a goal that is unrelated to pain may modulate attention for pain. In this context, Schrooten et al[42] and Schrooten et al[43] demonstrated that attention bias to pain-relevant information can be inhibited when individuals are engaged in the pursuit of another salient, non–pain-related goal (eg, monetary reward and punishment contingent on the performance on a second task).

Second, *individuals may pursue a goal related to pain.* This scenario may develop when people are highly anxious, catastrophize about the pain, or attempt to control or avoid pain.[23] This is frequently the situation when pain becomes chronic and/or uncontrollable. In this context, Eccleston and Crombez (2007) describe how chronic pain patients may become stuck in a vicious cycle of (1) worrying about pain, its cause and its consequences and (2) misdirected problem-solving behavior, that is, the continued search to control the pain through medical care that will unlikely solve the pain problem. Crucial to the escape from this vicious cycle is the enablement of patients to disengage from the pursuit of this unachievable goal of pain relief, and fostering the ability to live a valued life with achievable goals despite the presence of pain.[44] The pivotal role of (pain related) goal pursuit in explaining the behavior of individuals in pain is equally endorsed in a contemporary revision of the fear-avoidance model of pain.[45] In particular, it is suggested that depending on the interpretation of an individual whether the pain is threatening or not, one will prioritize pain control overvalued (nonpain) life goals. In the case that pain is intuitively considered as reflective of bodily harm that needs to be controlled, it will be accompanied by fear and avoidance responses (exploitation). Long-lasting avoidance behavior may then consequently interfere with daily life goals producing high levels of disability and negative affect. In the case that pain is not interpreted as a signal that threatens bodily integrity, this adapted model suggests that individuals prioritize the pursuit and approach of valued life goals (see later: exploration), which in turn results in pain recovery.

Cognitive Biases for Pain

A key concept to each of these motivational frameworks in pain is the influence of goal pursuit on cognitive processing of pain; whereby the way in which pain is interpreted, attended to, and memorized largely depends upon context and goal pursuit.[22,24] Over the past decades, researchers have investigated the existence and impact of cognitive biases in each of these domains (interpretation bias, attention bias, and memory bias). In particular, they have addressed and operationalized these biases as stable, trait-like phenomena influencing the disability and distress in the context of pain.[28] Research findings investigating the presence and impact of cognitive biases have been inconsistent. In this context, Van Ryckeghem and colleagues recently called for a shift in understanding cognitive biases for pain as stable, trait-like phenomena to dynamic, functional phenomena influencing individuals' behavior and the impact of pain upon their life. In this functional-contextual framework, cognitive biases are considered functional phenomena driven by goal pursuit and context variables, whereby adaptive cognitive processing requires the ability to shift flexibly in the way that situation-specific features are interpreted in line with presented demands. These demands may then depend upon the actual threat level and the possibility to influence this threat balanced with the pursuit of ongoing and/or future non–pain-related goals.[28] Preliminary evidence supporting this view shows that the magnitude of attention bias for pain information indeed depends upon the presence of important goals.[46,47]

Clinical Implications

Adopting a motivational framework of pain has important theoretical and clinical implications. In particular, a motivational perspective suggests that the goals people pursue should be taken into account within a therapeutic context. Indeed, a proper understanding of the specific goals people pursue may help to understand the attempts people make to gain control over their behavior, cognitions, or emotions. Therefore, it is of the essence that goals are clearly identified and their properties well understood.[28,48] One way of doing this is by means of motivational interviewing[49] or through personal project analysis.[44] Once these goals are identified, self-regulation strategies may be instantiated to help individuals reach their goals despite the presence of pain.

THE PURSUIT OF VALUED ACTIVITIES IN THE PRESENCE OF PAIN: AN INTERPLAY BETWEEN CONTROL AND MOTIVATION

The experience of pain demands attention, irrespective of an individual's pursuit of valued daily activities, it calls

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for a change in action.[7] As such, pain can cause conflict across motivated behavior.[50,51] An ongoing dilemma is faced when we experience pain, akin to explore-exploit conceptualizations[52]: should we alter our goal-directed action to protect the self from potential bodily harm (eg, resting a painful ankle, taking anti-inflammatories, and going to a doctor—exploit) or should we persist in our goal-directed action (climbing to the summit of the mountain—explore)?

Another layer of complexity to this dilemma is that the very prediction of negative consequences associated with valued activity interruption (eg, I would not be able to climb to the summit) may evoke pain experiences, involving emotions such as fear and regret. Indeed, the fear of pain is found to be more disabling than the pain itself.[53,54] In this case, the prediction of the consequences of the pursuit of a valued activity can over time be integrated as part of a multidimensional defensive system, eliciting a highly automatized habitual response pattern.

Whether attention is directed towards protection (exploitation), for example, interrupting one's activity as recommended in techniques of pacing; or whether one continues to engage in an activity despite the presence of pain (exploration), the individual is confronted with a multifaceted drive-to-goal decision problem.[55]

Drive-to-goal decision problems can be considered as an ongoing process of coordinating behavior in line with one's goals. Recently, such problems have been conceived under an active inference framework, which conceptualizes drive-to-goal decisions across the neural hierarchy, timescales, and contexts. Specifying 3 hierarchical domains: low, intermediate, and high levels that correspond to ascending complexity of cognitive involvement, Pezzulo and colleagues provide a structure from which to consider how control and motivation influence behavior. Although differentiating between control and motivational domains, the core implication of the theory is one of the integrations, whereby goal-directed behavior is contextualized through a hierarchical inference system that propagates and prioritizes multiple and often competing goals.[55]

This hierarchical framework is particularly relevant to pain, encompassing not only potential goal conflicts of attending to or persevering with pain but also the phenomenological implications of predicting negative emotions associated with goal interruption. At the "low levels" of control and motivation, an interplay between bottom-up information exists, closely aligned with a biological imperative (homeostasis). This is contextualized at the intermediate level that may correspond to particular beliefs about the consequences of action (eg, if I keep walking I'm going to cause long-term damage to my back). At the higher levels of the hierarchy, there exists an integration of motivation and control with respect to goal-oriented behavior (eg, I have to reach the summit of the mountain). Importantly, there is interaction within and between each level of the hierarchy that ensures the contextualization of bottom-up information with top-down predictions.

On the basis of this theory of motivated control, we can understand the behavior of an individual who experiences pain while attempting to sustain a pain-irrelevant valued activity as the result of a process of *active inference* in terms of a hierarchical Bayesian inference on the basis of an identification of probabilities to achieve goals and their contextual value.

The drive-to-goal problem in pain, formalized through active inference, contextualizes the problem across different timescales, competing goals, and hierarchical domains. Every time pain attracts attention, a dilemma will arise anew, involving the generation of predictions about possible action sequences (policies) and the preferred outcomes. This is important in view of recent research showing that chronic pain often displays substantial variability during a day[56] and the so-called "flare-ups," repetitive increases of pain lasting for hours, days, or weeks.[57,58] Static postures that are known to cause pressure on the spine and "overdoing a task" belong to the most often reported precursors of a flare-up.[59] Further clinical studies, using accelerometer-based assessments of physical activity revealed, that patients showing habitual patterns of pain-related endurance, display more often static, spine-stressing postures during an 8-hour observation period of daily life compared with patients showing fear-avoidance or adaptive pain response pattern.

We know from experimental research in dual-task paradigms that task persistence increases when pain is less intense,[34,60] when the pain is not new or rather predictable.[61]

Imagine a patient who experiences back pain sometimes for months (*not new*) at a low to moderate degree (*rather predictable*), who knows from physician diagnosis that this pain is not caused by serious illness (*not threatening*). Under these contextual conditions, the probability of persisting in doing housework such as ironing despite pain is relatively high (Fig. 2). Fear of not being a good housewife if interrupting the task will be more intense than the fear of pain and injury. In contrast, when this patient experiences a flare-up of pain rated "8" (on an 11-item NRS), the pain gets intolerable, forcing interruption and rest, which may be followed by negative mood, loss of control, and a decrease in self-efficacy.

Persistence in an activity despite high levels of pain until inactivity has been compelled was labeled as "overactivity,"[62,63] an important precursor of chronic pain problems.[64] Contemporary models of pain responses, such as the avoidance-endurance model (AEM),[65,66] provide a conceptualization for different solutions of these pain-related drive-to-goal decision problems. The model proposes that the ability to flexibly switch attention direction from pain to the concurring activity and to flexibly vary between avoiding pain (eg, realizing a short break) and regaining the activity after this break (feeling refreshed) is a precondition of early recovery from a pain problem. In contrast, the highly rigid interpretation of a pain and related activities as threatening associated with marked avoidance behavior (the fear-avoidance pathway) and the rigid pattern of persistence in physical and social activities despite increasing levels of pain (the endurance pathway) refer to maladaptive solutions of the drive-to-goal decision problem, leading to chronicity of pain through underactivity or overactivity.

The presence of underactivity and overactivity in the AEM-related subgroups has been shown in patients with low back pain and overtly accelerometer-based assessment of daily life activity.[67,68] High rigidity in goal striving including attention direction and behavioral responses may be developed through the effect of high intensive affectivity[69] and/or a high degree of automaticity in habitual behavior,[70] where the interrelation between active inference and habitual learning is still under debate.[52,71,72]

Conclusions for clinical practice imply the assessment of these activity-related pathways characterizing cognition, motivation, and behavior of an individual patient as primarily fear-avoidant, persistent, or flexibly adaptive with the goal to target the following steps of treatment

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Name Mrs. P.W.

Datum:			
Time	**Situation/activity**	**Meds**	**Pain (0-10)**
1h			
2h			
3h			
4h			
5h			
6h			
7h			
8h			
9h	Breakfast, pain while walking	Diclo	4
10h	Homework, Ironing		1
11h	Homework, Ironing		4
12h	Hobby, pottery		4
13h	Hobby, pottery		5
14h	Walking trip with friend		6
15h	""		6
16h	""	Diclo	8
17h	Homework, hoovering		7
18h	Homework, hoovering		7
19h	Dinner		5
20h	TV		3
21h	TV		3
22h	TV		2
23h	bedtime		2
24h			

FIGURE 2. Excerpt from a patients' diary on daily life activities/situations, pain intensity ratings (0 to 10) and medication.

respectively. Conducting an analysis of flare-ups of pain during daily activities, exposure methods will help a patient to overcome fear of pain, that occurs at an early timepoint of flare-up and regain activity gradually. In contrast, a patient with a pain response pattern of rigid persistence, pain-irrelevant goals have to be addressed on all motivational levels, the intermediate level (Spring cleaning has to consider some short breaks in order to limit the increase of pain
and fatigue), the high order level (I'm a good housewife even if spring cleaning is not finished within a day), and last but not least at the low level of concrete self-reference thoughts and speech (I just need a short break for refreshing). The overall therapeutic goal as part of patient education should address a flexible balance between increasing strain and recovery.[64]

CONCLUSIONS

The role of action in the relation to the experience of pain has been explored from 3 different perspectives: an embodied pain framework, a motivational approach, and with respect to pain responses within the avoidance-endurance model. Common to these 3 approaches is the contextualization of pain in relation to goal-orientated action. We initially ground action as part of an evolutionary process that enables us to disambiguate an uncertain world. From this perspective, the experience of pain can become "stuck" when action is persistently interrupted. Context is further explored in relation to the pursuit of goals in the presence of pain. From this motivational perspective, pain can both influence and become the target of goal-directed behavior. Finally, we differentiate the way in which goals are pursued in the presence of pain, taking into account the hierarchical nature of motivation that can influence the trajectory of one's pain experience. In taking a wide view of pain and action, we expose the nuances within drive-to-goal behavior in the presence of pain. This has implications for the clinic, specifically in relation to assessing the multifactorial influences that shape action in pain. But it also seeks to go further, considering the broader environment in which we make decisions and the influence that other professionals, outside of typical health care roles, may play a part in the maintenance and resolution of pain.

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