Neuroscience and Biobehavioral Reviews 34 (2010) 214–223

Contents lists available at ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

Review

The sensory-discriminative and affective-motivational aspects of pain

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ARTICLE INFO

Keywords:
Pain
Perception
Bodily sensations
Objectivity

ABSTRACT

What is the difference between pain and standard exteroceptive perceptual processes, such as vision or audition? According to the most common view, pain constitutes the internal perception of bodily damage. Following on from this definition, pain is just like exteroceptive perception, with the only difference being that it is not oriented toward publicly available objects, but rather toward events that are taking place in/to one's own body. Many theorists, however, have stressed that pain should not be seen as a kind of perception, but rather that it should be seen as a kind of affection or motivation to act instead. Though pain undeniably has a discriminatory aspect, what makes it special is its affective-motivational quality of hurting. In this article, we discuss the relation between pain and perception, at both the conceptual and empirical levels. We first review the ways in which the perception of internal damage differs from the perception of external objects. We then turn to the question of how the affective-motivational dimension of pain is different from the affective-motivational aspects that are present for other perceptual processes. We discuss how these differences between pain and exteroceptive perception can account for the fact that the experience of pain is more subjective than other perceptual experiences.

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1. Introduction

The scientific study of pain faces the apparent contradiction of trying to investigate from an objective point of view a phenomenon whose characteristics seem to be its essential subjectivity and privacy. How, one might ask, can a subjective phenomenon be studied objectively? Alternatively, one might ask whether there is

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doi:10.1016/j.neubiorev.2008.07.008

any sense in which pain can be considered as an objective phenomenon. One way to approach these questions is to investigate the difference between the experience of pain and exteroceptive perceptual experiences such as, for example, the visual perception of an object or the auditory perception of a tone. Indeed, these perceptual experiences also have both objective and subjective components: They are directed toward external objects but the experience itself is subjective.

Two main approaches have responded somewhat differently to the question of how pain relates to perception. One school of thought has emphasised the similarities between the experience of pain and the perceptual experience in the case of exteroception (e.g., Schiller, 1956). The most popular philosophical account of pain which takes this approach is today known as 'representationalism' (see Armstrong, 1962, and Pitcher, 1970, for early expressions of this viewpoint; the canonical modern version has been defended most vociferously by Tye, 1997, 2006). According to those who hold this view, conscious experiences can, in general, be accounted for in terms of what is represented by those experiences. In the case of vision, this applies as follows: I have a veridical experience of a red square when there is a red square which is perceived and represented internally as a red square. Similarly, according to the representationalist viewpoint, pain experiences consist of representations of the fact that there is tissue damage. The way pain feels coincides completely with its represented content: The fact that there is tissue damage at a certain location in the body (Tye, 2006). More precisely, according to this view, pain is an experience that has an intentional content. To say that an experience has an intentional content is to say that the experience is an experience *of* something, an experience that has the property of being about something other than itself. Attributing an intentional content to the experience of pain has one direct implication: It gives to the experience conditions of validity. Pain can be 'correct' or 'incorrect', as a function of whether or not it veridically represents objective signs of tissue damage. In summary, according to the representationalist viewpoint, pain is considered in a similar manner to all other perceptual processes. It is the perception of an object or event, which can either be represented correctly or incorrectly.

But can this representationalist approach genuinely do justice to the way pain feels, that is, to the purely subjective properties of pain? Many philosophers refer to such subjective properties as *qualia* (plural of 'quale'). Qualia, according to theorists who subscribe to them (e.g., Chalmers, 1996; Levine, 1983) are special properties that need to be invoked in order to account for the specifically conscious aspect of experience. Qualia are the ways things are experienced as opposed to how they objectively are. In the case of seeing a red square, qualia enter as the properties of 'felt redness' and 'felt squareness'. Following Nagel's (1974) famous phrasing, qualia determine 'what it is like' to be consciously aware of red or squareness. Qualia, seen as determining what it is like to have a conscious experience, i.e., as determining the 'phenomenal' properties of that experience, are defined in contrast with the objective properties of perception. In the example of seeing a red square, the objective properties would be the material constitution and the physical properties of the red square as well as the corresponding bodily and neurophysiological processes involved in that perception. Many philosophers (e.g., Chalmers, 1996; Levine, 1983) have argued that the lack of an intelligible connection between the objective properties of perception and the associated qualia is deeply problematic. For how can the physical properties of a red square (or some corresponding neurophysiological processes) lead to an experience at all and to the experience of red in particular? Could not one easily imagine that all the objective events occur without any additional conscious events?

According to philosophers sympathetic to the notion of qualia, although we understand the causal processes involved in pain, we do not understand the link between the objective and the subjective realms (Levine, 1983). Pain is often considered to be an experience in which the role of qualia is obvious. But how to define these qualia? Many philosophers are naturalists who agree that every genuine feature of the universe, including the features of consciousness, must be given a place in the overall picture of nature as being built up by science (Polger, 2003). However, qualia, if understood purely in opposition to objective physical properties of the brain and of the world, do not seem to fit that profile. Nevertheless, phenomenal consciousness exists. Naturalists, therefore, need to account for phenomenal consciousness in a naturalistic way that is without qualia.

This is precisely what the representationalist approach claims to do. According to this approach, conscious experience can be explained without referring to qualia, that is, only by invoking the content of representations. In such a case, there is nothing more to the qualitative properties of consciously experiencing a red square than representing a red square. One is perceptually aware of a red square, not because some special inner properties or qualia of 'redness' or 'squareness' intervene over and above the objective properties of the brain and world, but rather because a representation is activated in the brain with the content that there is a red square 'over there'. The representationalist slogan is that the 'phenomenal content' is identical to the 'representational content' of the experience. From this, it is clear that the representationalism and the perceptual view of pain are natural allies. For, if pain is genuinely perceptual, the representationalist approach to consciousness applies to it without much further ado. There is nothing more to the qualitative feeling of pain than that it represents bodily damage.

Critics of representationalism have pointed out that the idea of reducing the experience to a representational content, although plausible for the case of exteroception, simply does not work for the case of pain (e.g., Block, 2006). Indeed, whereas the way things seem and qualitatively feel in perception might be exhaustively described in terms of objective properties, the same does not hold for pain. The 'experienced painfulness' is not like the 'perceived squareness', a subjective take on an objective property 'out there'. For what property would it be in the case of pain? Answering 'an objective pain' does not hold as there are no such things as objective pains that could exist without someone perceiving them (whereas there are unobserved squares). This is precisely the respect in which there is a difference between pain and exteroception: There is for pain, but not for perception, the absence of an *appearance/reality distinction*. In order to clarify what is meant by this distinction between appearance and reality, consider the case of visual hallucinations: i.e., when someone has the visual experience of an object which is not, in reality, there. In that case, the experience of the object is not generally considered as being a genuine perception but rather as being a false perception (Aydede, 2006; Block, 2006). One does not see the object but hallucinates it. Both common sense and the most widespread definitions of pain (e.g., IASP, 1986) stipulate that the situation is different for the case of pain: Whoever seems to perceive pain, genuinely perceives pain. This means that, in order for pain to be genuine, the object of perception does not need to be present or at least, there is no strict correspondence between the experience of pain and what occurs objectively in the body. This particularity of pain is reflected by the fact that 'central pain syndromes' (long lasting pains caused by damage to the central nervous system) and 'referred pain' (when, for example, one feels a pain in one's left arm when there is a problem with one's heart, e.g., see Barr and Kiernan, 1983) are considered to be fully fledged examples of pain (Aydede, 2006). Pain thus seems to be significantly more subjective than other kinds of perceptual process in the sense that not only the experience itself, but also what is experienced, is entirely dependent on its being experienced. The absence of any appearance/reality distinction means therefore that, for pain, things are exactly as they seem to be.

Both of the above accounts seem to be, in part, correct: Pain normally has an object (the tissue damage) and it is nevertheless true that a felt pain remains 'genuine' in cases in which there is no such object of pain. How can one obtain an account of the experience of pain that does justice both to its objectivity (and thus its similarity with exteroception) and to its excess of subjectivity? In contrast to these two philosophical approaches that emphasise only one particular aspect of pain, scientific accounts of pain have typically proposed that the experience of pain consists both of sensory-discriminative and affective-motivational aspects (e.g., Melzack and Casey, 1968; see also Jones et al., 1992). An interesting philosophical interpretation of this categorisation relates these two aspects of pain to the difference between the *discriminative content* of pain and how pain is qualitatively experienced, that is, its quality of *painfulness* or *hurtfulness*. Below, we synthesise a number of pertinent philosophical arguments together with salient contemporary cognitive neuroscientific findings in order to try and determine the similarities and differences between pain and the other intransitive bodily sensations (such as itch, tickle, and tingle) and exteroceptive perceptions (such as vision or audition). We start by discussing a conception of pain according to which pain is considered as being similar to all other perceptual processes except that, for the case of pain, what is perceived is internal. We then propose that though pain shares some resemblance to exteroceptive perception it actually represents a specific kind of perception, in that what is discriminated does not completely fulfil the normal criteria of objecthood. In particular, we would like to argue that the discrimination of pain has specific spatial properties. However, in having these characteristics, the subjectivity of a painful experience is not opposed to objectivity though it is opposed to objecthood (i.e., to the property of being an external object, as correlated with specific laws of spatial exploration, see Section 2). We then go on to discuss the question of subjectivity in terms of the affective-motivational aspect of pain. We consider the proposal that the experience of feeling pain (i.e., the quality of painfulness) should be understood as a form of bodily intention which is conscious, but which is beyond our control. We discuss whether this allows for a more satisfactory account of the subjectivity of the experience of pain. We conclude that this dual conception of pain might allow one to do justice to both the similarities and differences between the experience of pain and exteroceptive perception and, in particular, to account for the special ways in which pain can be said to be subjective.

2. Pain as the perception of an internal object or event

One way in which to account for the specificity of pain is to consider that pain is similar to other perceptual processes except that the object of perception, instead of being external, is an event that takes place in the perceiver's own body. Thus, pain would be a special kind of perception in that it is a perception 'from inside' (note that the same specificity also applies to any interoceptive sensation such as thirst, see Craig, 2002; Ramsay and Booth, 1991). In order to understand what is meant by perception from inside and to evaluate the extent to which this view accounts for the specificities of pain, we follow the analysis provided by Dokic (2000). First of all, Dokic underlines the fact that one characteristic of an objective perception is the existence of a causal and informational link between the experience and its object. In the case of exteroception, this link goes through the external world. The object of sight has a causal impact on the receptors in the eye through the light bouncing off the object and impinging on the receptors of the back of the eye. In the case of pain, at the physiological level, the nociceptors (i.e., high threshold type Aδ or C sensory neuron, see McMahon and Koltzenburg, 1990, see also Berkley & Hubscher, 1995, for a discussion of the stimuli conveyed by the touch and nociceptive pathways), situated in most parts of the corporeal tissues are activated when there is corporal damage in these tissues (note that they also respond when there is the threat of corporal damage, e.g., see Butler and Moseley, 2003, for a review). The nociceptors respond selectively to certain damaging stimuli, in particular mechanical deformations, temperature increase, and the increased concentration of certain chemical irritants (e.g., Fields et al., 1994). The nociceptors seem to play a role comparable to that of the rods and cones in the eye with the key difference being that the stimuli impinging upon them originate from a location within the body. Thus, one way to understand what is meant by 'internal perception' and thereby to account for the difference between pain and exteroception would be to say that pain is similar to exteroception but with the object of perception being internal to the body. In such a case, your pain is your pain because it corresponds to the perception of something that occurs inside your body. While others could have a third-person access to that pain through objective measurements of bodily activity, only you have the right direct internal link to it. In other words, while third person links to your pain would pass through the outside world, yours is direct, because it occurs by a direct physical link inside your body.

However, although it is certainly true to say that the nociceptors that play a crucial role in the experience of pain are located within the body, it could have been otherwise.[1] In the same way that certain artificial devices (prostheses), such as glasses or binoculars extend the limits of our visual field of view, we could imagine prostheses that extend the experience of pain outside the limits of the space defined by our body (Dokic, 2000). The phenomenon of the 'rubber hand illusion' reveals that direct physical links, internal to the body, are less important for a body part to be felt as belonging to the body than might at first be thought. Building upon this finding, a recent functional magnetic resonance imaging (fMRI) study by Lloyd et al. (2006; see also Ehrsson et al., 2007) has revealed that pain-related brain mechanisms can be activated in the absence of any internal corporal signal. The participants in Lloyd et al.'s study viewed a rubber hand placed above their real hand which was hidden from view. The experimenter then synchronously rubbed both the participants' real hand and the artificial hand until the participants reported feeling the sensation of touch as coming from the artificial hand. This feeling is thought to occur as a result of the multisensory interaction between vision, touch, and proprioception, with vision typically dominating over proprioception in the case of sensory conflict (e.g., Botvinick and Cohen, 1998; Ehrsson et al., 2004; Lloyd, 2007; Makin et al., 2008). Next, either a neutral object (a cotton bud) or a potentially harmful object (a syringe) touched the rubber hand. Viewing this action resulted in more pronounced activation in the superior parietal and inferior parietal cortices when viewing a painful stimulus than when viewing a neutral stimulus touching the rubber hand, when the latter was placed in an anatomically plausible position. On the basis of these results,

[1] It should be noted that the case of phantom limb pain is no exception. Although the perceiver seems to feel pain in a locus that does not correspond to his actual body, pain is nevertheless felt as occurring in an *apparent* bodily location. The experience of pain does not cease when the owner changes room, the pain follows her in all his/her displacements (Dokic, 2000).

Lloyd et al. went on to argue that the parietal cortex plays a central role in the visuo-spatial encoding of noxious threat. Lloyd et al.'s results therefore provide evidence in support of the view that the cortical processing related to pain can be engaged purely on the basis of visual perception (i.e., in the absence of any corporeal signal of pain or threat to the participant's body).

Other studies have corroborated the view that pain-related processes (such as fear) are not necessarily mediated by purely corporeal signals. For instance, a study by Armel and Ramachandran (2003) revealed that once participants experience the rubber hand illusion, their galvanic skin conductance responses (SCRs) increase when the participants perceived the rubber hand being suddenly 'injured'. Ehrsson (2007) reported similar results when the normal participants in this study had out-of-body experiences. In Ehrsson's study, the participants viewed their own body with the perspective of a person sitting behind them (thanks to a pair of head-mounted displays connected to two video cameras). Once the participants experienced this illusory body as if it was in some sense their own, their SCRs increased when viewing this illusory body "hurt" with a hammer. Although it should be noted that an increase in sweating is certainly not synonymous with the experience of pain, but only gives an indication of its presence, the experiments described in this section (Armel and Ramachandran, 2003; Ehrsson, 2007; Lloyd et al., 2006) all suggest that pain-related feelings (such as fear) do not necessarily have to be experienced from the inside in order to become part of a genuine corporal experience.

These results appear inconsistent with Pitcher's (1970) suggestion that pain, as opposed to touch, cannot be projected to the end of a tool. In the next section, we highlight the limits on the exteriorisation of pain. However, what can be concluded from the fact that it is possible to project pain or at least fear of corporal damage to a rubber hand (or even to a table, see Armel and Ramachandran, 2003) is that it is an incidental fact that sensible qualities such as pain occur at specific locations. However, it is not an incidental fact that these locations are termed the *body* of the person (Armstrong, 1962). Thus, an inversion of the co-determination of body and bodily sensations can be made. On the one hand, we can define bodily sensations as occurring on one's own body; on the other hand, it is the bodily sensations that allow for a specification of the space of one's body. According to this point of view, a *necessary* condition for a limb or an object to be integrated into our 'lived' body is that a bodily sensation can be felt in this part (Dokic, 2000). However, we note that this is not a *sufficient* condition, given that we are not conscious of all of our body parts and given that we can experience pain in an area which is not anatomically contextualised for us (such as in the case of stomach pain). The fact that this condition is not sufficient is also revealed by the existence of referred pain (e.g., Barr and Kiernan, 1983; McCabe, Haigh, Halligan, & Blake, 2005a), and by the possibility for some patients suffering from complex regional pain syndrome to experience pain in a limb that they do not entirely feel of as being their own (e.g., McCabe et al., 2005b). The crucial point here is that what is experienced as you, as your body, is not determined by pre-existing physical bodily links, but rather is determined by systematic relations between your perceptions mediated by different sensory modalities. Thus, your 'self' is not necessarily a physical entity, bounded by your skin, but also involves whatever can be synchronised and integrated into your perception and your coordinated perceptually driven action (Clark, 2003).

The question of the role of physical internal links in experience becomes more complex if one considers a technique reminiscent of biofeedback designed to modulate pain through looking in real-time at the activation of one's own brain areas. In a study by deCharms et al. (2005), chronic pain patients were able to learn how to control activity in their rostral anterior cingulate cortex by observing their own brain activity displayed on a computer screen in order to decrease their experience of pain. Thus, although there is a perfectly legitimate sense in which how the brain affects itself is always internal, deCharms et al.'s study shows that the way the brain exerts an influence on itself can be augmented by the use of external means.

3. The spatial specificities of pain

From the foregoing, it can be concluded that it is not of primary importance that the events giving rise to pain belong to the physical body or that these events are mediated by purely internal physical links (such as the nerves going from peripheral nociceptors to the central nervous system). Thus, the subjectivity of pain cannot be accounted for by appealing to its property of being an internal perception. In the following, we argue for the view that the different laws of spatial exploration underlying the perception of external objects and the perception of bodily events are better candidates for giving an account of the differences in the experienced subjectivity between pain and exteroception.

The link between space and objectivity has been pointed out by Pacherie (2001). According to her, conceiving of the object of an experience as objective is primarily conceiving of it as spatial. More precisely, our conceptual scheme – that is, the way in which the fundamental concepts that we use to think about the world are structured – involves as a fundamental element, the idea of the existence of an objective world. This objective world contains particular objects that exist independently of us and that can become objects of our perceptual experience. Within this conceptual framework, the notions of space and objectivity are so intimately linked that it seems almost impossible to conceive of a perceptual world whose existence is independent of the experience we have of it, which is not a world of objects included in a system of spatial relations. The experience of pain also involves a spatial dimension: It is a pain localised in a particular part of my body. However, this characteristic does not seem sufficient to conceive of the experience of pain as being objective in the same sense as other perceptual experiences. Here, we would like to propose that this difference with respect to objectivity may be due to the lack of three specific spatial characteristics: transitivity, reversible exploration, and interposition.

3.1. Transitivity

Armstrong (1962) divided the bodily sensations into two categories: transitive and intransitive. Reporting transitive bodily sensations such as temperature or pressure involves the use of a transitive verb whose object is a sensible quality of an external object or event. For example, when saying "I feel the warmth of his hand" one reports a tactile perception of something external to her. The transitive bodily sensations, such as the tactile or gustatory sensations are causally linked to the experience of an external object or event. On the other hand, reporting intransitive bodily sensations does not involve referring to an external object. According to Armstrong, pain is probably the most prominent member of what he termed intransitive bodily sensations, which also includes tingles, itches, and tickles, as well as hunger and thirst. When one reports a tingle or a pain, even when she uses a sentence where the verb seems to be transitive, such as "I feel a sharp pain in my right thumb", the same experience can be described using an intransitive verb such as "my right thumb aches". For Aydede (2006), it follows from such distinctions that it does not make sense to talk about pain without someone being there to experience it. That is, intransitive bodily sensations cannot exist without someone's feeling them. This means that the appearance/reality distinction does not apply to them. In contrast with pain, the object of a visual experience can exist without someone perceiving it.

An essential characteristic accounting for the intransitivity of such bodily sensations is that they are always localised in the space of the body. It is not only a pain; it is a specific pain in my right thumb. The distinction between the space of our body and the space of other objects has been characterised by the fact that the frontier of our body is a frontier that the usual spatial relations do not cross (e.g., Merleau-Ponty, 1945). Indeed, one of the specific characteristics of bodily sensations is that they remain localised in the same body part when the body moves. However, the question arises as to which more specific properties underlie the distinction between the space of the body (in which pains are localised) and the space of external objects. In the following, we discuss two of these properties: reversible exploration and interposition.

3.2. Reversible exploration

A specificity of bodily sensations is that they cannot be reversibly explored. Even if a given pain is felt at a specific spatial location, one cannot have the experience of pain from different points of view. One always experiences a given pain from the same viewpoint (note that the same specificity applies to any interoceptive sensation such as thirst or hunger, see Craig, 2002). On the other hand, one can vary the angles from which she visually perceives a flower, that is, one can have different points of view on that object. This absence of reversible exploration prevents the cause of our proximal sensory stimulation from being attributed to an exterior and distinct object (a phenomenon known as distal attribution). Following on from Piaget (1936, 1937), it is the extraction of systematic co-variations between self-movement and the resulting pattern of stimulation that allows for the development of distal attribution and subsequently subserves the acquisition of the concepts of space and objecthood. In other words, it is only by voluntarily bringing our sensing organs into various relations with respect to the objects that we learn to be sure as to our judgments of the causes of our sensations (e.g., Helmholtz, 1909). For example, we explain the table as having an existence independent of our observation because, at any moment we like, simply by assuming the proper position with respect to it, we can observe it. One example of the link between externalisation and active exploration is the phenomenon of 'intracranial localization' in audition. When a binaural sound is presented over headphones, observers will localise this sound within the phenomenal limits of their head (e.g., Yost and Hafter, 1987). However, when the same binaural stimulation is coupled with rotations of the head and displacements of the body, observers are more likely to report distal attribution (e.g., Loomis et al., 1990). Such results therefore suggest that the attribution of the source of a sound to an external location is dependent on head movements. What this means for the perception of pain is that, in the absence of any possibility of reversible exploration, no distal attribution can occur. This fact helps to explain why pain is not considered as being independent of the experience that we have of it.

3.3. Interposition

When exploring an object visually, one can experience, under certain conditions, the interposition of an obstacle between herself and the perceived object. This is not the case when experiencing pain (nor when experiencing any bodily sensations). The possibility of interposition allows a distance between the perceiver and the object to be perceived thereby playing a crucial role in allowing a comprehension – as a separate spatial object – of the source of stimulation. The importance of the possibility of interposition for the occurrence of distal attribution can be illustrated by reference to a recent study involving the use of sensory substitution devices (Auvray et al., 2005). In this study, the participants were equipped with a visual-to-auditory sensory substitution system without being given any specific information about it. The device converted the video stream produced by a head-mounted camera into a sound stream. The results revealed that the participants' abilities to attribute their sensations to a distal cause were significantly reinforced by the possibility of manipulating an obstacle located between the object and the perceiver. In other words, the possibility of experiencing interposition allowed them to understand the source of the stimulation as being a distant object. These results therefore suggest that, contrary to the experience of pain (and to the experience of all intransitive bodily sensations), in exteroceptive perception, it is thanks to the possibility offered to temporarily isolate the stimulation that observers can dissociate an object, source of sensations, and the movements allowing variations of those sensations. Thus, the absence of this condition for reaching objecthood has the implication that the object of pain (e.g., tissue damage) is less objective than is the case for exteroceptive perception.

3.4. Implications: space and objectivity

The role of reversible exploration and interposition in making it possible to conceive of the object of perception as objective can be explained as follows: In order to conceive of the existence of an external reality that exists independently of its being perceived, we have to draw a distinction between the order of experiences and the order of objects in that experience; in other words, a distinction has to be drawn between the subjective succession of phenomena and the permanent structure where the objects of experience have their own relations of coexistence and succession (e.g., Kant, 1787). As stressed by Condillac (1754), if we just passively received sensations, we would not understand that these sensations refer to objects that exist in an external world. Indeed, if all our knowledge about the world came from our sensations, and if sensations were just passive modifications of our minds, how could we ever infer the existence of an external world? For Condillac, it is thanks to our exploratory movements that we can extract the spatial organisation at the origin of our sensations; and it is the spatial existence of the objects in the world that allows us to consider them as external. In other words, it is the possibility we have, after a succession of movements, to come back to the same sensation from the same position that allows for the comprehension that an exterior object is the cause of our sensations (see Philipona et al., 2003; Poincaré, 1905, 1907).

To summarise the argument here, a simple temporal succession of patterns of stimulation does not allow for the perception of an object conceived of as existing independently of its being perceived. Our exploratory movements, that is, the possibility of having different points of view on the same object or the possibility of manipulating an obstacle, allows for the dissociation between an object, the source of sensations, and the movements that allow for variations of those sensations. This serves as a ground for the constitution of the spatial existence of the objects in the world that then allows us to consider them as external. In other words, spatialisation and objecthood emerge simultaneously.

The implication for our conceptualisation of pain is that the perception of pain differs from standard perceptual processes in terms of specific spatial properties. Particularly, the spatial characteristics of a painful experience are its intransitivity (due to the fact that pain is always localised in the space of the body), the fact that pain cannot be reversibly explored, and the fact that the perception of pain does not allow for the interposition of an additional object between the perceiver and what is being perceived. It should be stressed that, in having these characteristics, the subjectivity of a painful experience is not opposed to objectivity, but it is opposed to objecthood (as determined by the set of laws underlying spatial exploration described in this section). As a consequence, it is only within a conceptual scheme that associates objectivity and spatiality (a conceptual scheme that we do not wish to endorse here) that the sensory-discriminative aspect of pain can be defined as purely subjective. In other words, in its sensory-discriminative aspects, pain is not radically different from perception: That is, pain is not considered as absolutely subjective, whereas perception would be objective. Pain has an object too but, due to the difference in its spatial characteristics, this object is not fully objective in the spatial sense in which the objects of perception are.

4. The affective-motivational aspect of pain

4.1. The impossibility of reducing pain to a purely perceptual process

So far, we have given an account of how pain differs from exteroceptive processes in its perceptual dimension. To do so, we have considered pain only insofar as it is comparable to perception. However, pain cannot be reduced to a perceptual registration of information. First of all, many studies have revealed that neither pain behaviours nor the activity of nociceptors provide an accurate measure of tissue damage (see Melzack and Wall, 1965; Meyer et al., 2006; Wall and McMahon, 1986). One of the reasons for this is that pain has an *anticipatory* dimension: Rather than being invariably a reaction to actual tissue damage, pain also occurs whenever there is the threat of tissue damage (Melzack, 1996; Moseley, 2007a; Wall, 1999). To illustrate this anticipatory function of the pain system, it has been shown that nociceptive neurons in area 7b of the monkey brain, respond with increasing strength to temperatures between 47 and 51 °C that is, just below the level at which tissue damage occurs (Dong et al., 1994). In addition, it has been proposed that the fear of pain and (re)injury may be more disabling than pain itself, with these pain-related fears being one of the possible origins of chronic pain for some patients (see Vlaeyen and Linton, 2000, for a review). The fact that pain plays an anticipatory function in addition to a mere registration of actual damage makes sense from an evolutionary perspective, given that this minimizes the likelihood that the organism will engage in damage-inducing behaviours. In order to play this anticipatory role, pain should have a motivational force: It should lead the organism to engage in various types of behaviour, including the avoidance of certain actions. Here we hit upon the second reason why pain cannot be reduced to its perceptual dimension: Pain is also essentially *motivational* in nature. Thus, to paraphrase Moseley (2007b; see also Butler and Moseley, 2003; Melzack, 1996), rather than providing an accurate indication of the state of the tissues, pain provides a conscious manifestation of a pre-conscious perception of threat to body tissues that motivates us to get our tissues out of danger.

The impossibility of reducing pain to its perceptual content and the necessity of its motivational aspect is well illustrated by the failure to substitute pain. For instance, Brand et al. tried to develop prosthetic systems to substitute pain (see Brand and Yancey, 1993). These devices were primarily designed for patients suffering from leprosy. These patients do not feel anything in their leprous members and the absence of feelings of pain results in self-generated damage. Indeed, Brand (1966) argued that the loss of limbs affected by leprosy does not come from an unavoidable rot but rather from an accumulation of injuries caused by the lack of attention paid to these limbs. Brand et al. (e.g., Brand and Ebner, 1969) built a system that alerted the user to damaging activities in their leprous limb thanks to the operation of pressure stimulators located in an intact part of their body. However, such devices did not prove to be particularly useful. The patients, having access only to such abstract information, were not forced to react and, over time, came to ignore the signals. Brand subsequently concluded that this kind of system could only work if it brought a compulsion to react and he therefore transformed the alerting signal into a painful electric shock delivered to an intact body part. However, this system did not work as well as had been anticipated either. First, because the patients involuntarily interpreted the signal less as a danger to avoid than as a kind of punishment. Second, the system remained under the patients' control. Therefore the patients could always switch it off, especially if the signal lasted too long; whereas natural pain cannot simply be turned off and persists for at least as long as the danger threatens (Brand and Yancey, 1993). It should be noted that the possibility of substituting sensations from a leprous limb remains for the case of touch. For instance, Bach-y-Rita et al. (2003) reported that when their patients used a special glove that sent the tactile stimuli normally accessed by a leprosed finger to an intact body part, they were able, after only a few minutes, to distinguish between different textures. Interestingly, the patients reported feeling the sensations as coming from their leprous finger. Thus, in this case, pain, as opposed to touch, seems to involve something more than just its sensory-discriminative content.

The impossibility of substituting for pain highlights two important aspects of pain. First, it shows that a purely perceptual model of pain is at best incomplete. Merely providing information about actual, or even potential, body damage does not suffice to elicit genuine pain. Though there is a perceptual aspect to pain, this perceptual aspect has to come with a motivational force as well. However, and this is the second point, this motivational force has to be beyond the control of the organism feeling the pain. The latter seems prima facie to be in conflict with the fact that stress-induced analgesia can block the sensation of pain (see also Wiech et al., 2008 for the example of placebo-induced analgesia). For example, athletes and soldiers sometimes succumb to serious injury, but they report being unaware of the pain until the end of the competition or battle. Melzack et al. (1982) reported that as many as 37% of the patients arriving at an emergency clinic reported a period, normally of about an hour but lasting up to nine hours, of absence of the experience of pain after the injury. However, this does not show that pain was under the conscious control of the injured patients in these cases. For nothing indicates that, at some point, they explicitly considered the pros and cons of feeling this pain and subsequently reached a decision based on that. Rather, if there is any assessment at all, it seems to be an implicit process by which the body adapts so as to function optimally, given a number of goals currently being pursued by the organism (Cannon, 1939, named this 'the wisdom of the body').

Another objection may be made to the view that pain is more than perception: One can take the existence of cases of pain without motivation as indicating that a purely perceptual pain is possible. The purest manifestation of a pain without the feeling of being hurt occurs in pain asymbolia (first described in Schilder and Stengel, 1928). More recently, pain asymbolia has been described as a 'sensory-limbic disconnection syndrome' (Berthier et al., 1988) because damage to the insular cortex interrupts cortical-limbic connections. Patients suffering from pain asymbolia retain the capacity to perceive pain, as distinct from touch, but in general their pains have lost their threatening character. For instance, such patients describe a pinprick as being painful without withdrawing the receiving hand. Instead, they smile upon feeling their pains and they cooperatively forward their hands for painful stimulation. Such patients also damage their bodies by disregarding the nociceptive signals that are nevertheless perceived (see Grahek, 2007, for an extensive discussion of pain asymbolia). It should, however, be stressed that pain asymbolia cannot save the case for theorists willing to identify pain with perception. Indeed, from the fact that under abnormal circumstances a condition of pain without hurting exists, it would be inappropriate to conclude that pain is solely perceptual. For that would be taking an exception to have the status of a rule. It would be like arguing from the fact that it is possible to write with a pen mounted on one's head, that writing is essentially achieved through moving the head instead of the hands.

4.2. The neural correlates of the affective-motivational aspect of pain

The fact that pain involves more than a perceptual aspect has driven many neuroscientists toward adopting a theory of pain in which it is seen as having both perceptual-discriminative and affective-motivational components (e.g., Melzack and Casey, 1968; Wall, 1999). Correspondingly, neuroscientists have suggested that the sensory-discriminative and affective-motivational components of pain are sustained by different neural structures: The neural activity underlying the sensory-discriminative aspect of pain is thought to occur in the somatosensory thalamus, primary somatosensory cortex (S1), and secondary somatosensory cortex (S2), whereas processes underlying the affective-motivational aspects of pain are located in the medial thalamus, amygdala, and limbic cortex (e.g., Jones et al., 1992; see also Kulkarni et al., 2005). It has been shown that these aspects of pain can be manipulated independently. In a study by Rainville et al. (1997), the participants under hypnotic suggestion estimated that the affective component of pain changed whereas the estimated intensity of pain remained constant. In this case, only the activity in the areas associated with the affective-motivational aspect of pain showed a variation of activation.

It should be noted that recent neuroimaging studies have revealed that the affective components of pain, but not its discriminative aspects, are crucial to the empathy for others' pain (Morrison et al., 2004; Singer et al., 2004; although see Bufalari et al., 2007). In addition, Avenanti et al. (2005) (see also Avenanti et al., 2006) have shown that the motor system may also be involved in the empathy for pain. Furthermore, there is now good evidence that the experience of pain is related to action. Indeed, studies have shown that the motor cortex (an area crucial for planning actions) and the anterior cingulate cortex (involved, among other things, in attention, motivation, and motor planning) are activated during the experience of pain (e.g., Farina et al., 2003; Ingvar, 1999).

4.3. Painfulness as a motivation to use our body differently

The affective-motivational aspect of pain adds to the mere discriminatory aspect a factor of dislike or unpleasantness and a factor of motivation for action. Consistent with the neuroscientific findings described above, some philosophers have seen an opportunity here to provide an account of the qualitative properties of the experience of pain. Indeed, instead of trying (as the representationalists discussed in Section 1 do) to account for the phenomenal properties of pain in terms of the discriminated representational contents or in terms of qualia, they try to account for the phenomenal properties in terms of their motivational force. For instance, Clark (2006) has proposed that the felt or qualitative aspect of painfulness is not a quale, but it can be identified with pain's motivational force (see also Grahek, 2007; Klein, 2007). Pain hurts insofar as it exerts a motivational force on an individual. It follows from this that when pain comes without motivation, one is still aware of the objective content of pain (e.g., the tissue damage) but one's experience lacks the additional, but essential, ingredient of painfulness. In such a case – and only in such a case – pain (or its remnant) is just like perception. Following on from such a line of reasoning, it can be said that, unlike the exteroceptive perceptual experience, whose identity is primarily fixed by its links to inputs, pain's identity is to a very significant degree fixed by its links to outputs. This can be illustrated by referring again to the case of pain asymbolia where patients still report discriminating a pain, without it being experienced as threatening (Grahek, 2007). The patients' pains no longer have the quality of painfulness and thus they are no longer genuine pains because they are stripped of their motivating force.

The identification of pain's most prominent qualitative property with a motivational force makes sense phenomenologically only if the way in which pain motivates is construed as distinct from the way explicit intentions motivate. For pain is experienced as 'occurring to us' rather than as something which is intentionally pursued: The motivating force of pain is beyond our control. It acts as what Merleau-Ponty (1945) has called 'an intention of the body': It moves us, but in a non- or pre-intellectual way. In other words, the evaluation of threat to bodily tissues is outside of our deliberate awareness and intentional control, and in that sense pain is seen as a conscious manifestation of a pre-conscious evaluation of the potential danger to tissue (see Moseley, 2007a). Moreover, pain's motivating force is hard to resist. The necessity of this dimension of compellingness in order for pain to genuinely have the quality of hurting appears clearly from the fact that the attempts to build devices that substitute for pain have failed (e.g., see the studies reported by Brand and Yancey, 1993). As described in the previous sections, these devices did not provide signals that forced an individual to react and hence they did not give rise to genuine experiences of pain. Such an identification of the quality of being hurt with pain's motivational force is consistent with evolutionary considerations. It is highly adaptive for biological organisms to be motivated to act in ways that prevent further bodily damage. Adaptation gets even better if this motive is felt with the force of compulsion: If the organism could only *not* feel it in unusual circumstances (such as stress-induced analgesia, in which not feeling pain is arguably more efficient than feeling it). The motivational aspect seen as an essential component of pain also allows for an account of the lack of an appearance/reality distinction for pain, present in cases of exteroception. The fact that pain counts as full-blooded pain when there is painfulness without tissue damage can be taken to indicate the essential role of the motivational component in pain. Pain remains painful whenever its outgoing, action-oriented connections remain in place, even in the absence of normal incoming damaging stimulation. Of course, exteroceptive perceptions can motivate actions as well. For instance, while hiking in the jungle, if you see a tiger approaching you, your visual experience will motivate you to seek refuge. However, unlike the case for pain, this threatening character is not necessarily present: As a visitor in a zoo, with a barrier to keep you safe, you might have a quite similar visual experience, but without the threatening and therefore motivating character.

The specification of a painful experience as linked to a compelling motivation to act might throw light on the puzzling phenomenon of the disappearance of phantom-limb pain. Patients who have had a limb amputated sometimes report being subjectively able to control the movements of their phantom limb (e.g., Melzack, 1992; Peréz-Barrero et al., 2003). This possibility has been explained neurofunctionally in terms of the fact that the reafferent signals from motor commands sent to the phantom limbs are still monitored in the cerebellum and parietal lobes (Ramachandran and Rogers-Ramachandran, 1996; see also Von Holst, 1950, for the reafference principle; Sperry, 1950, for the corollary discharge model; and Poulet and Hedwig, 2006, for a review). However, in other cases, the phantom limb is experienced as being paralysed, that is, the patients report having lost their subjective volitional control over the limb. This may be attributable to a preamputational paralysis due to peripheral nerve damage or to the absence of visual and proprioceptive feedback (Ramachandran, 1998). In this latter case, patients sometimes report feeling a vivid pain. Indeed, a study by Sherman et al. (1984) revealed that 70% of amputees keep on feeling pain in their phantom limb even 25 years after amputation.

In order to eliminate the phantom-limb pain, Ramachandran and Rogers-Ramachandran (1996) built a mirror box. The patients placed their intact limb in front of a mirror in such a way that the mirror reflection corresponded to the perceived location of their amputated limb. Through the use of this device, when the patients were asked to perform symmetric movements of both of their limbs, they received visual feedback showing that the phantom limb now obeyed their commands. When using this mirror box, six out of ten patients reported that they did not only see but also feel the movements of the phantom limb. Crucially, four of these patients reported that this procedure relieved the pain in their limb (Ramachandran and Rogers-Ramachandran, 1996). Additional studies involving sham-controlled trials of mirror therapy versus genuine trials have demonstrated the efficacy of mirror therapy for relieving pain in phantom limbs (e.g., Chan et al., 2007; see also Moseley, 2007c, for the use of virtual walking in order to reduce paraplegia-related pain).

It should be mentioned here that the question of the percentage of patients who might benefit from this therapy, and the question of the amount of time using the mirror box required to obtain positive results remain controversial (see Brodie et al., 2007; see also Moseley et al., 2008, for a recent review). However, these results suggest that pain in amputees' phantom limbs may arise from an incongruency between bodily intentions (i.e., motivations to act) and sensory feedback. In other words, it may result from the fact that each time the amputees attempt to move their phantom limb, they receive visual and proprioceptive sensory feedback showing that their commands have not been obeyed. Therefore, when a congruency between bodily intentions and sensory feedback is artificially created (by using the mirror box) the 'phantom' pain can be made to disappear (see also Sathian et al., 2000). It should be mentioned that neurofunctional imaging studies have discovered a region of cortex that becomes more active in response to incongruence between motor intention, awareness of movement, and visual feedback (Fink et al., 1999). In this study, bimanual active movement with a congruent visual feedback bilaterally activated regions in dorsolateral prefrontal cortex and inferior posterior parietal cortex, and in the left cerebellar hemisphere. The same task performed with incongruent visual feedback activated a single region in the right dorsolateral prefrontal cortex.

Building on this finding, Harris (1999) has suggested that this region might correspond to the right cortical centre monitoring incongruence of sensations (CIS). According to Harris, in amputees, the absence of proprioceptive and visual information congruent with motor intention activates the CIS which results in a pathological phantom-limb pain. Following on from this view, such inappropriate cortical representation of proprioception falsely signalling incongruence between motor intention and movement results in pathological pain in a similar way that incongruence between vestibular and visual sensation results in motion sickness. It should be noted that, consistent with this view, a study by McCabe et al. (2005a) using mirror reflection recently suggested that painful sensations can arise from an incongruency between motor commands and visual feedback i.e., different movement of the seen and hidden limbs (although, Moseley et al., 2005 have found that such incongruency does not evoke pain, although it can give rise to symptoms of peculiarity, foreignness, and swelling; see Moseley and Gandevia, 2005, for a review; see also the works of Bayer et al., 1991, for experimentally induced pain feelings in the absence of painful stimulation).

In summary, the studies reported in this section suggest that the experience of painful sensations in the absence of nociceptive stimuli can arise when the bodily intentions are incongruent with the sensory feedback visually received. In line with what has been said already, if hurtfulness is correlated with a motivation to act differently, then it might be issued when there is a mismatch between the motor commands and the perceived motor output. On the other hand, when bodily intentions are made to correlate with the perceived sensory feedback (e.g., thanks to the use of the mirror box, e.g., Ramachandran and Rogers-Ramachandran, 1996), there is no longer any need to act differently and the hurting disappears.

4.4. The avoidance and restorative functions of pain

Several models about the interruptive function of pain (see Eccleston and Crombez, 1999, for a review) have proposed that pain urges one to act in order to escape a danger. Pain and threat signals interrupt, distract, and demand attention (e.g., see Koster et al., 2004; Van Damme et al., 2007), and doing so, they impose an overriding priority on an action-oriented system so as to urge escape and avoid harm. Consistent with this view, Klein (2007) raised the question of what pain is motivating for. In what he termed 'an imperative theory of pain', Klein argued that we should see pain on a par with hunger and thirst, which he considered to be 'imperative sensations'. According to Klein, in contrast with hunger and thirst, which have the imperative impact of driving to eat or to drink, pains cannot be characterised by a single type of action they motivate us for. Klein argues that pains are unified by what they motivate *against*, in particular, using the specific body part felt as painful. The core of the imperative theory of pain then is that pain is a negative imperative that prohibits one to use the painful body part in the way that one normally does.

The imperative theory formulated by Klein (2007) seems far too restrictive. Indeed, characterising pain only by proscription seems to go against the adaptivity of pain: In order to be truly functional, pain also has to be sensitive to contextual demands. To use Klein's (2007) example: Pain should prevent you from wanting to stand on a broken ankle. However, it cannot be restricted to it: Pain should not discourage you from continuing to use your ankle if dying is the only other option. Thus, there is a balance between achieving several goals in a tangled hierarchy to be struck, which might rely on accumulated 'bodily wisdom' (Cannon, 1939). Stress-induced analgesia seems to be one outcome of such a balancing act.

Grahek (2007) has provided a useful discussion of the avoidance function of pain versus the restorative function of pain. The first function incites us to act in such a way as to avoid tissue damage from occurring, for instance 'retracting your hand before the burn actually occurs'. This function is certainly associated with a system that motivates positively for actions. Grahek correlates this function with the fast acting Aδ-nerve fibres and notes that their activity is followed by positive bodily reactions such as movement and manipulation. The second system, mediated through C-nociceptive nerve fibres, is the restorative system, which reacts by inhibiting movement and manipulation in the affected areas.

This system allows for optimal condition to recover from deep injury (Melzack and Wall, 1988). The imperative theory thus applies only to part of the pain system or to one aspect of pain's functionality. Positive actions are certainly among those that pain motivates for and this is quite understandable from the insight that evolution will tend to favour most the active prevention of damage, rather that the reactive restoration of it.

5. Discussion

The specificities of pain, both at its sensory-discriminative and affective-motivational levels, allow for a more parsimonious perspective on pain than the conception of pain as an internal perception. That view was correct in that pain is directed toward a discriminated content: A potentially injured body part. However, this object does not have the same spatial objectivity as the objects of exteroception. The object of pain, the pain felt in a part of the body, is therefore subjective in the sense that it lacks full-blooded objecthood. As discussed earlier, the lack of objecthood of the object of pain comes from the lack of some specific laws of spatial exploration; this particularity being due to the fact that pain is dependent on the person's body (see Dokic, 2000). However, pain is not limited to its discriminated content; it also involves an affective-motivational dimension. It is unpleasant and motivates an individual toward some actions and away from others. The motivational force of pain might be identified with the unique qualitative properties of pain: its painfulness or hurtfulness. Within this framework, hurtfulness becomes a hardly controvertible tendency to act in certain ways, or refrain from acting in certain others.

It should be noted that this solves an important problem for the representationalist account. For applying to the hurtfulness of pain the same account as the representationalist view (i.e., pain as perception) applies to discriminated bodily damage is problematic. Following on from such an account, painfulness would become an additional perceived content associated with bodily damage. Pain would then convey a double message: There is something occurring in this body part and this something is painful. But conceiving of hurtfulness as just an additional perceived element does not explain why we are so strongly affected by it. Of course, one could say that the perceived element of painfulness has an unusual motivational force, but this would not explain, in any sense, how and why it has this force. Following on from the motivational account, to experience pain does not consist of reacting to some additional content besides the discriminated content: It does not come apart from the tendency to react itself. This account of painfulness might also do justice to at least one sense in which pain is subjective. Your pains have subjective painfulness because only you have a hardly controvertible urge to change your actions in certain ways. Just like your desires to have all your hair shaved off is yours in the sense that it will be fulfilled only when your hair is shaved off, your hurtfulness as a motivation to adapt your ways of acting are yours, in the sense that only your actions can be the appropriate response to the motivation.

The experience of pain, conceived both as perceptual and motivational, would then be subjective to a higher degree than other perceptual experiences for two reasons: First, as described in the initial part of this paper, because the object of the experience of pain does not reach objecthood; and second, because the experience of pain is motivational and motivations are necessarily subjective, in the individualistic sense indicated.

Acknowledgements

E.M. was supported by the Research Foundation, Flanders; M.A. and E.M. were supported by a funding from the University of Antwerp.

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