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PAIN AND TOUCH

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Abstract (184 words):

When one contrasts pain with the classic five senses, discussions generally focus on vision, which is taken as the paradigmatic example of perception. An intentionalist might argue that if the phenomenal difference between feeling and seeing bodily disturbances cannot be explained at the level of the content, it can be so at the level of the mode of presentation, and more particularly at the level of the structure of the spatial phenomenology of pain. Here I will argue that the spatial phenomenology of pain shares some key features with touch by contrast to sight, but these similarities should not make us neglect major differences between these two types of bodily sensations. I shall then draw the consequences of these differences for the awareness of one's body as one's own. In brief, to fix the boundaries of the body that one experiences as one's own, one must answer two questions: (i) where does the body stop, and the rest of world start? and (ii) what matters for self-preservation? I will suggest that touch primarily answers the first question, whereas pain primarily answers the second question.

When one contrasts pain with the classic five senses, discussions generally focus on vision, which is taken as the paradigmatic example of perception. One may then note that feeling an injury clearly differs from seeing it and wonder how to account for the phenomenal difference between the two modes of awareness. The task is especially difficult for those who characterize pain in intentional terms: if painful experiences represent injuries, then they have the same content as visual experiences. Why, then, do they feel different? An intentionalist might reply that if the phenomenal difference cannot be explained at the level of the content, it can be so at the level of the mode of presentation (Bain, 2003). There are then several ways to go to distinguish the painful mode from the visual mode, but I will exclusively explore the structure of the spatial phenomenology of pain. This issue should be clearly distinguished from the issue concerning the location of pain: the question is not where pains are, but where they are *felt* to be located. There is then hardly any debate that they are felt to be located on one's body, and yet the relationship between pain and bodily awareness has been barely discussed in the philosophical literature. Here I will argue that the spatial phenomenology of pain shares some key features with touch by contrast to sight, but these similarities should not make us neglect major differences between touch and pain. I shall then draw the consequences of these differences for the sense of bodily ownership.¹

1. Sight and touch

Let us first consider the sense of touch. In his seminal paper 'Sight and Touch', Mike Martin (1992) highlights structural differences between visual and tactile experiences. He compares the following two examples: seeing a ring-shaped object, as a Polo mint, and

¹ By sense of bodily ownership, I mean the awareness of *the body* in pain *as one's own*, and not the subjectivity of pain (what it feels like *for me* to be in pain).

grasping a glass in one's hand. In both cases, one is aware of the circular shape but the way the shape is presented differs. I see the Polo mint on the background given by my visual field. The visual field should be understood here as the spatial array of visual impressions. Within my visual field, I am aware of the ring of the mint, but also of the hole inside. By contrast, when I feel the glass between my fingers, there is no directly comparable tactual field, or at least it does not play the same role as the visual field. Indeed what spatially organizes my tactile sensations is beyond touch itself: it involves being aware of the glass within a space that is not tactually perceived. What grounds my tactile awareness of the circular shape is the awareness of the body that holds it. According to Martin, bodily awareness is thus constitutive of touch.

Martin's conception of the relation between tactile sensations and bodily awareness can be articulated into four main claims. Firstly, tactile experiences are localized within the spatial frame of reference that is provided by the awareness of bodily boundaries:

We thought of the visual field as a spatial region within which visual awareness was possible. A bodily space would be a region within which bodily awareness was possible. The candidate would then be the apparent body itself, since the apparent limits of the body are the apparent limits of possible sensation. (Martin, 1992, p. 202)

Imagine that you have a cross on a map indicating "you are here", but the map is completely blank: there is no reference point, no orientation, no border. The cross is then of little interest. It is only when you put a tracing paper with all the information drawn on it over the blank map that you can know where you are. Likewise, tactile experiences need to be structured by the awareness of bodily boundaries. Tactile sensations are experienced as being located on the background of what may be conceived as a map of the body, that is a representation of the enduring properties of the body, including the structural organization

of the various parts of the body independently of current bodily posture. This hypothesis can be traced back to Bonnier (1905), who first used the term of body schema to refer to the spatial organization of bodily sensations. In 1911, Head and Holmes posited the existence of a schematic model of the skin surface used for localizing bodily sensations. More recently, O'Shaughnessy (1980) argued that thanks to a long-term body image sensations are experienced as being at more than isolated body points. On his view, bodily properties are ascribed to specific locations within the long-term body image. The long-term body image is thus the background on which bodily sensations are experienced, their spatial frame of reference. Here I shall prefer the term of body map, which is less theoretically laden and which captures well the idea that it represents the boundaries of the body.

The second main feature of tactile experiences is that they involve being aware of a space that goes *beyond bodily boundaries*:

In being aware of one's skin as a boundary of one's body, one has some sense of space extending beyond that boundary. (Martin, 1992, p. 213)

The awareness of a larger space and the awareness of bodily boundaries are two facets of the same coin: one cannot be aware of bodily boundaries if one is not aware of what is beyond of those boundaries, and vice-versa. Being aware of bodily boundaries involves being able to contrast what is inside from what is outside. In touch, there are at least two ways to delineate the apparent limits of the body, and thus to be aware of a larger space: (i) by being aware of the locations at which one can feel tactile sensations and those at which one cannot; and (ii) by being aware of the resistance of the external world on the skin.

In virtue of the awareness of bodily boundaries and what lies beyond, tactile experiences can ground the awareness of the body in which one feels sensations *as one's own*:

For awareness of one's body as one's body involves a sense of its being a bounded object within a larger space, and that just is to locate it within a space of tactual objects. (Martin, 1992, p. 213)

In order to be aware of one's body as one's own, one needs to discriminate one's body from what is not one's body. This discrimination, however, should not be phrased in terms of self versus non-self to avoid a circular account of the sense of ownership. It can be simply phrased in spatial terms, between inside and outside bodily boundaries in which one can experience tactile sensations. Tactile sensations are experienced only within the apparent boundaries of one's own body. I am aware that there cannot be tactile sensations that do not fall within the limits of my own body as I experience it: I do not feel touch in one body as opposed to another body; I can feel it in my own body only. Consequently, tactile sensations confer a sense of ownership on the body part in which they are felt to occur.

So far I have described the bodily side of the spatial phenomenology of tactile experiences, but they also have an exteroceptive side: they are not only about the body on which pressure is exerted (the sensation on my fingertip), but also about the object that exerts this pressure (the glass). The two sides, however, are interrelated. More specifically, according to Martin, the exteroceptive content of tactile experiences uses the body as a *template*:

A sense of one's own spatial organisation can become a sense of the spatial order of things around one: the body is a template to measure things in the world. (Martin, 1992, p. 205)

For example, when I hold the glass in my hand, thanks to my kinaesthetic experience of the relative location of my fingers, I can tell that the glass is circular. Likewise, I can feel the circular shape of the glass by running my fingertip around its rim: my tactile sensations

are then temporally and spatially organized by the kinaesthetic experience of my hand movements. The posture of the body is geometrically congruent with the external objects so that its awareness gives me access to the spatial properties of the external object.²

Although some have argued that bodily information plays a role for sight too (O’Dea, 2011), it is clear that the spatial phenomenology of visual experiences does not meet the description that Martin offers of tactile experiences. It is true that when I see a red spot on my hand, I am visually aware of my hand within a larger space, which can contain other objects. But the boundaries of the body that I see are not co-extensive with my visual field. I see the red spot on my hand, but I could have seen it on many other hands. Therefore, I do not feel as my own the hand that I merely see. Visual experiences lack the right spatial structure to ground the sense of bodily ownership (Brewer, 1995, Bain, 2003; Martin, 1995). What is of interest for us now is whether painful experiences meet the above description. Most views assume a unique spatial structure for all bodily experiences. However, one might wonder whether they are not neglecting major differences between painful and tactile experiences, and if so, whether these differences matter for the sense of bodily ownership.

2. Pain in the outside world

In his taxonomy of bodily experiences, Armstrong (1962) draws a distinction between transitive and intransitive sensations. Transitive bodily sensations, such as tactile sensations, have independent objects, whereas intransitive ones, such as pains, have no straightforward non-mental object. Armstrong’s distinction is generally used to question

² The template model of touch, however, is controversial. In particular, it might be able to account for the perception of spatial properties such as shape, but not for the perception of other tactual properties such as weight, pressures and solidity. For discussion, see Vignemont and Massin (2015).

the perceptual status of pain. For instance, if one assumes that perceptions provide awareness of objects and states of affairs that exist independently of their being perceived (Shoemaker, 1994), then pain does not seem to qualify as being perceptual. However, the comparison between pain and touch that I want to draw here is orthogonal to the perceptual debate; it concerns their spatial phenomenology, and the role played by bodily awareness to shape it. Hence, what matters is whether we are aware of the boundaries of our body and of the larger space to which our body belongs when we are in pain in the same way we do when we are touched.

2.1 Painful objects

If a man runs his head with violence against a pillar ... He feels nothing in the stone but feels a violent pain in his head. It is quite otherwise when he leans his head gently against the pillar, for then he will tell you that he feels nothing in his head, but feels hardness in the stone. (Reid, 1764, p. 56)

Intuitively, it might seem that the content of our painful experience is filled in by our body only. The underlying hypothesis is that pain is not about the external world. This is obviously true of headaches, visceral pains and muscle pains because there are no properties external to the body to be aware of. This is also true of exogenous pains that last after their external causes have stopped (restorative pains, for instance). One may, however, wonder whether this is also true at the time at which the pain is externally induced. One can indeed note that this type of pain generally motivates defensive behaviours that involve being aware of an external world that is at the origin of the pain, whether it is to remove one's limbs from whatever is hurting it or to remove whatever is hurting it from one's limbs. We thus have conflicting intuitions: when I burn my hand, the burning sensation is all about my hand only, and yet it makes me withdraw my hand *from*

the burning pot. The question thus arises: does pain have an exteroceptive content like touch or not?

Let us slightly modify Martin's example. The glass that I am in contact with is now extremely hot so that when I run my fingertip around its rim or when I grasp it, I burn my hand. Do I feel the circular shape of the glass in that case? Here one might have expected pain to 'inherit', so to speak, an exteroceptive content from touch.³ In support of this hypothesis is the fact that thermal perception seems to work that way (Smith, 2011). Compare the following two examples: you stand in the street and your hands feel cold or you take snow in your hand and the snow feels cold. According to Smith, by themselves, thermal sensations are intransitive bodily sensations, like pains, but when they are combined with tactile sensations of pressure, they become derivatively exteroceptive. Yet what works for thermal sensations does not work for pain. According to Smith, even when combined with touch, pains remain essentially painful experiences and the painfulness overrides or obliterates exteroceptive experiences. Pains are opaque: they do not give direct access to the properties of the painful object (i.e. the object that is causing the pain); they only give access to the painfulness of the body. Hence, through pain I am only aware of the burning pain in my hand; I am not aware of circular shape of the burning glass.

The alleged opacity of pain may seem surprising from an evolutionary perspective. Intuitively, it seems important for survival to learn which objects are potentially harmful. However, as Grice (1962, p. 36) noted: "Almost any type of object can inflict pain upon us, often in more than one way". We all know how painful the cut of a sheet of paper can be and yet we do not want to categorize paper as being painful. Quite often, it is the

³ Actually, most noxious stimuli simultaneously activate both tactile fibres and nociceptive ones. This is one of the main challenges for the scientific study of pain because it is difficult to isolate what is specific to pain itself.

specific way that we interact with objects that is at the origin of pain, rather than the objects themselves: a chair is innocent as long as one does not bump into it. Knowledge about the shape or the size of the object that causes pains does not increase the fitness of the organism. This is well illustrated by the following study (Mancini et al., 2015). Participants were asked to evaluate the distance between a pair of noxious or tactile stimuli. Although they could be more reliable in localizing noxious ones than tactile ones on some parts of the body (the abdomen, for instance), participants still failed to accurately judge the distance between two noxious stimuli, while they succeeded for tactile distances. Mancini and her colleagues concluded that the function of touch is to acquire knowledge about the spatial properties of external objects, whereas pain is indifferent to these properties. But is it indifferent to all of them?

2.2 *Painful location*

I have argued that pains are not experiences of *painful objects*, even derivatively through touch. But we still need to account for the fact that externally induced pains motivate and justify a specific range of behaviours that involve some awareness of the external world. Hence, there must be some dimension to pain that goes beyond bodily boundaries. I now want to propose that pains are experiences of *painful locations*.

There is indeed one spatial property of the painful object that matters for survival at the time the pain occurs, and this is its location. One needs to know the location of the object that is at the origin of the occurring pain in order to react accordingly, by withdrawing, for instance, and by avoiding putting one's limb back there. Being aware of the painful location, however, does not mean being aware of the painful object that occupies this location. Roughly speaking, it does not matter whether I am burning my hand because of the flame of a fire or because of a burning glass. Instead, being aware of the painful

location means being aware of the egocentric location of one's painful sensations: all that matters is that I am burning my hand *here*, and that I should go *there*.

According to O'Shaughnessy's (1980), bodily sensations are "sensations-at-a-part-of-body-at-a-point-in-body-relative-space". Another way to put it is to say that bodily sensations have two types of felt location, which I respectively call *bodily location* and *egocentric location*. Bodily location is the location in a specific part of the body, no matter where the body part is located. When I move my hand, the bodily location does not change. By contrast, egocentric location depends on bodily posture, and is thus given within an egocentric frame of reference: it is the location relative to the other parts of the body at the time of the sensation. The spatial duality of tactile sensations is well illustrated by the Japanese illusion. Cross your wrists, your hands clasped with thumbs down. Then turn your hands in toward you until your fingers point upward. If now I touch one of your fingers, you will have difficulty not only in moving the finger that is touched, but also in reporting which finger it is. If tactile sensations had only bodily locations, then this complex posture should make no difference. A touch on the right index finger remains on the right index finger no matter where the finger is located. The difficulty that you have in the Japanese illusion, however, shows that (i) the relative location of body parts matters and (ii) bodily location can be perceived as being in conflict with egocentric location (for instance, a right hand on the left side of the body).

Like tactile sensations, pains have both bodily and egocentric locations and it is the latter that is primarily required to account for defensive behaviours. As Evans (1985) defines it, the egocentric space is a "behavioural space", the space within which one acts. Hence, in order to appropriately guide my withdrawal, I need information about the location from which I should retrieve my hand relative to the current posture of the rest of

my body. If I fail to know it, then pain can no longer play its protective role. This is the case, for instance, in patients who suffer from peripheral deafferentation. These patients can have no proprioceptive and tactile information about most of their body, but they can still experience pain. With their eyes closed, they are not aware of the relative location of their limbs. Consequently, when they cut their index finger, they are able to localize their pain in their finger, although they have no idea where their finger is in egocentric space: pain has a bodily location without an egocentric location. Their action is thus impeded: if they do not see their finger, they cannot put their finger in their mouth for instance. In some limited circumstances, one can thus feel pain without egocentric location, but in other circumstances egocentric locations can take priority over bodily locations, as illustrated by the following study. In Thunberg's thermal grill illusion, first demonstrated in 1896, a sensation of painful heat is elicited by touching interlaced harmless levels of warm and cool bars to the skin (for instance, index finger warm, middle finger cold, ring finger warm). What happens when the fingers are crossed? If the illusion only relied on the bodily location of the thermal stimulations, then it should change nothing. However, it was found that the illusion was based on egocentric locations, that is, on the relative locations of the stimulated fingers. With the middle finger crossed over the index finger for instance, the cold stimulation must now be applied on the index finger (which is in between the middle finger and the ring finger) for the illusion to work (Marotta et al., 2015).

Hence, pains have egocentric locations, and this is so even in the absence of external cause (e.g. when I have a headache, I need to know where the left painful side of my head is to put an icepack on it). In this sense, pain can be said to be anchored in external space. But there is a range of defensive behaviours that seems to involve that and more. Consider the following example. It feels as if a small splinter was in your feet. You do not see it but it really hurts. You decide to remove the splinter and to do so you rely on where it hurts.

Suddenly you scream: “It’s here!” because this is the point that is the most painful. What this example illustrates is that pain can be an appropriate epistemic ground for knowledge about the world outside the body. This is so because at the time at which the pain is externally caused the egocentric location of pain normally coincides with the egocentric location of the distal source of the pain.⁴

Hence, in pain not only is one aware of a larger space in which one’s body is located; one can also be aware of the location of the distal source of one’s pain within this larger space. This source, however, is individuated purely spatially and there is no existential commitment as to whether there is an object at this location. If one wants to claim that externally-induced pains have an exteroceptive content, it is thus in a very minimal sense, hardly to be compared with the exteroceptive content of touch. Furthermore, we do not have an access to the location of the distal source of pain independently of our access to the felt location of the sensation itself. Consider the following bodily illusion. If one’s biceps tendon is vibrated at a certain frequency, one feels one’s arm moving away. Then the felt position of one’s hand does not match with its actual location and thus, with the location of whatever might hurt one’s hand. In such a scenario, defensive behaviours are based on the felt location of painful sensations: I withdraw the hand in pain from the location at which I feel it to be, even if there is actually nothing there. Hence, the egocentric location of the sensation itself has pragmatic priority. It also has epistemic priority: if I burn my hand here, I assume that whatever is burning me is at this location. Painful locations that one is aware of should thus be primarily conceived of as the felt locations of the pains themselves given within an egocentric frame of reference, and only derivatively the felt locations of their distal source within the same reference frame.

⁴ By distal source, I mean whatever is causing the injury (the splinter, for example).

Hence, although pain is not about painful objects, one is not locked in one's body when in pain: the body is not only an inside, it has also an outside in which the body navigates and that can be harmful. This outside is given in body-related terms, but it is still a space that goes beyond the boundaries of one's body.

2.3 Solipsism

We have seen that both painful and tactile experiences involve the awareness of one's body within a larger space, but we have also seen that there is a striking difference between the two. In touch, one is aware of a larger space thanks to tactual encounters with objects at the surface of the skin. Hence, one is aware of one's body within a larger space that contains many objects. By contrast, in pain one is aware of one's body within a larger space, but there is no awareness of that larger space as being possibly filled by other objects. The path between thumb and mouth appears to fall outside the limits of the body, but it also appears to fall in empty space. Martin (1992) claims, "In the space of tactual objects, one's body is just one object among others", but in the space of pain, one's body could well be the only object. In this sense, pain could be said to be solipsistic.

Now one may wonder about the consequences of such solipsism. Imagine that you have never had any tactile experiences, but you have had painful ones. What kind of awareness of the world do you have? And of your own body? Much has been said about the primary role played by touch for our awareness of the mind-independency of the external world (Condillac, 1754). Clearly, pain would not suffice to ground such awareness. But could it suffice to ground the awareness of one's body as one's own?

To some extent, there is no need for a thought experience to answer this question. Arguably, one does not feel tactile sensations in viscera, but one can feel extremely acute

pain there. Whereas the localisation of touch is indeed limited to the surface of the body, pain has the asset to provide us awareness of what lies inside. Question is: does one feel one's kidney as one's own? O'Shaughnessy (1980, vol. 1) notes that there is no feeling of 'immediate presence' when it comes to our kidneys, unlike legs, hands or breasts. One might reply that internal organs are special cases because we cannot voluntarily move them. We can then turn to patients who are deafferented. As mentioned earlier, they have no tactile awareness on most of their body but they still experience thermal and painful sensations. Yet at the beginning of their disease, one of those patients reported that he no longer felt his body as his own:

Ian has described how he would sometimes wake to feel a hand on his face and not know to whom it belongs. Until he realised it was his own, the experience was momentarily terrifying. Since he has normal perception (...) of warmth in the hand, it is interesting that he cannot, or does not, use warmth of the hand alone to identify self from non-self. (Cole, 1995, p. 85)

The point that is made here concerns warmth, but could work as well for pain. As said earlier, thermal sensations inherit their exteroceptive content from touch, and in the absence of touch, they are solipsistic bodily sensations like pains. I propose that they fail to confer a sense of ownership to the patient's hand because of their solipsism. It does matter that one is not aware of one's body within a larger space *that contains other objects*. It is true that one can be aware of the frontiers of one's body by drawing a line between the locations at which one can feel bodily sensations and the locations at which one cannot feel sensations. This strategy is efficient both for touch and for pain, and both types of sensations can ground the awareness of bodily boundaries. However, bodily boundaries, I claim, are less 'sharp' for pain than for touch. The notion of sharpness here should be understood in epistemic terms. More specifically, solipsistic sensations provide fewer

grounds to the individuation of bodily boundaries than exteroceptive sensations. In touch, one is aware both of the frontiers of one's body and of the frontiers of the objects, thus allowing the contrast bodily space versus objects space. By contrast, in pain, one is not aware of painful objects, thus allowing only the contrast bodily space versus non-bodily space. The frontiers of one's body may then appear as contingent: the space that is not bodily could as well be occupied by the body since it is not occupied by anything else. What lies beyond the body is judged *in absentia* and the conviction carries less weight. Roughly speaking, boundaries are less meaningful when there is nothing beyond them. This in turn affects the sense of bodily ownership. Paradoxically, pain is too embodied, that is, too focus on one's body, to confer a sense of ownership to one's body.

3. A world without pain

We have just seen what it would feel like if you had never had any tactile experiences, but only painful ones. We can now ask the reverse question: what would it feel like if you had never had any painful experiences, but only tactile ones? Following Martin I assume that the sense of bodily boundaries is a necessary condition for the sense of bodily ownership. However, I shall now depart from Martin's view by arguing that the sense of bodily boundaries is not sufficient for the sense of bodily ownership. There is an additional type of awareness that is required, which pain provides.

3.1 The puzzle of tools

Let us further compare the spatial phenomenology of pain and of touch. They are both felt to be located within the apparent limits of one's body, as they are represented in the body map. Surprisingly, however, where one can feel touch does not always coincide with

where one can feel pain. In the case of touch, it is commonly accepted that tactile sensations can be felt beyond the biological boundaries of one's body at the tip of tools (Lotze, 1888; Martin, 1993; O'Shaughnessy, 2003). One might say, for instance, that the blind man is aware of the pressure exerted by obstacles on the floor *at the end* of his white cane. Such referred tactile sensations are possible because the body map extends to include the cane. However, there is no comparable sense in which the blind man could be said to feel *pain* at the tip of his cane. Of course he can wince when the cane falls on the floor. But he does not feel pain as being localized in the cane.⁵ Although there is a sense in which one can be said to feel resistance or vibration in a tool, the same cannot be said of pain. The fact is that one uses tools in harmful situations in which one would not use one's limbs. This is so because if a tool is damaged, one does not feel hurt. It is actually relatively essential that we do not feel pain in tools because if we did, then we would have a less extensive use of them and that would preclude technological progress: how do you keep a fire burning if you cannot use a stick to stoke the hot embers? This is not to say that one can feel pain only within the biological limits of one's body. Unfortunately, pain in phantom limbs does exist.

To recapitulate, one can feel pain and touch to be located in a missing limb, but one can feel only touch to be located in tools. The case of tool use can thus be taken as an example of touch-without-pain scenario. The question now is whether touch suffices to confer a sense of ownership to tools? In other words, do we feel tools as parts of our own body? It does not seem so. We manipulate hundreds of them during the day and it does not seem likely that we feel all those tools as parts of our body. Nor does it seem that we feel that we are losing a part of our body when we release the knife, the pen, the lighter or the umbrella.

⁵ Nor can you can tickle your pen or feel the urge to scratch the tip of your fork. The following discussion on the role of pain can be generalized to other affectively-loaded intransitive sensations, such as tickles and itches.

Hence, although we can feel tactile sensations to be located in tools, we do not generally feel ownership for them. There are limits to the awareness that tactile experiences can provide on their own.

At this point, one might dispute the relevance of the tool case because one experiences only *referred* sensations there and it is controversial whether they should be treated on a par with tactile sensations on one's own body.⁶ I shall now turn to cases of pain deprivation.

3.2 When the body becomes a tool

Melzack and Scott (1957) raised terrier dogs in isolation preserved from pain. They found that after their release the dogs required more intense electric shocks to learn avoidance responses and spent more time near the experimenter after he burnt their noses with a flame. Another pain deprivation study was done with infant monkeys that were raised preserved from all threats in the absence of potentially damaging objects and of elders who could slap or bite them. Still, they could hear, see and touch themselves. When released, these monkeys viciously bit their own limbs and torn their flesh (Lichstein and Sackett, 1971). It thus seems that if one has not been hurt before, pain partly loses its unpleasantness, or at least its motivational force. Since these animals were also in social deprivation, one might say that they could not learn from others what were bad for them and how to react to it. However, not to avoid pain is one thing, and to voluntarily injure oneself is another, and acts of self-destruction cannot be explained only by social factors. Interestingly, self-inflicted injuries can also be found in patients with congenital pain insensitivity. These patients are characterized by dramatic impairment of pain sensations

⁶ For discussion, see Vignemont (in press).

since birth, caused by a hereditary neuropathy or channelopathy. They show a complete lack of discomfort, grimacing, or withdrawal reaction to prolonged pinpricks, strong pressure, soft tissue pinching, and noxious thermal stimuli. Like the animals raised in isolation, they often engage in self-mutilation, including burns and auto-amputations of fingertips and tongues (Danziger and Willer, 2009; Nagasako et al., 2003).

I suggest that pain deprivation alters the awareness of one's body as one's own, which in turn can result in self-inflicted injuries. For instance, patients with congenital insensitivity to pain can describe that their body feels like an external object, a kind of tool. An eighteen-year-old boy with congenital pain insensitivity reported:

A body is like a car, it can be dented but it pops out again and can be fixed like a car. Someone can get in and use it but the body isn't you, you just inhabit it.

(Frances and Gale, 1975, pp. 116-117)

It thus seems that Descartes was right: "Nature likewise teaches me by these sensations of pain, hunger, thirst, etc., that I am not only lodged in my body as a pilot in a vessel" (*Meditation IV*). Without pain expertise, one is only as a pilot in a vessel. Injuring this specific body may then be a way to test whether it is one's own or not. Feeling something can then strengthen a fading feeling of confidence in the sense of bodily ownership, whereas feeling nothing can confirm that this body has nothing to do with one. Or it might be that one simply feels no sense of ownership whatsoever. If so, one is not voluntarily injuring oneself, one is rather injuring *a body*, which happens to be one's own. In other words, when patients bite their fingertips, they are not fully aware that they are biting their *own* fingertip. Failing to feel one's limb as one's own leads to a failure to protect it from harm.

What is especially interesting is that both the monkeys raised in isolation and the patients with congenital pain insensitivity can experience other types of bodily sensations.

For example, monkeys were not deprived of tactile experiences and patients with congenital pain insensitivity often show no abnormality in tactile processing. Yet it seems that this does not suffice for the development of the sense of bodily ownership: touch, and even self-touch, cannot suffice to compensate for pain deprivation in the drawing of the body that one feels as one's own.⁷ That indicates that touch and pain both participate to the delineation of the boundaries of one's own body, but in a different way.

3.3 *Beyond spatiality*

The relationship between touch, pain and the sense of bodily ownership is complex. On the one hand, if one has only painful sensations without tactile sensations, the boundaries of one's body are less distinctive and one is less likely to feel one's body as one's own. On the other hand, if one has only tactile sensations without painful sensations, one is more likely to lose track of what belongs to oneself, and thus of what one must protect. I thus suggest that touch and pain play two complementary roles for the awareness of one's body as one's own. Touch plays a *spatial* role. As Martin well describes it, it grounds the awareness of one's body within a larger space that can contain other objects, which in turn grounds the spatial awareness of bodily boundaries. This, however, does not suffice, as shown by pain deprivation (and referred sensations in tools). One can draw here a parallel with nationalism. A classic conception in social psychology is that we do not feel especially patriotic when we are merely aware of the boundaries of our country; we feel patriotic when we are aware that it matters to us when these boundaries are in danger. I propose here that pain plays this specific *affective* role. Pain gives a valence to bodily boundaries: it indicates that these boundaries are the ones to care about and to protect if

⁷ For further evidence in favour of the role of interoceptive feelings for self-awareness, see Craig (2003).

one wants to survive. It vividly highlights for the subject that what is inside bodily boundaries matters for the self, for its needs, its comfort, and its preservation. It thus teaches that it is important to keep track of them. Without pain, without even pain expectation, bodily boundaries are just spatial boundaries.

This does not mean that it is only when the body is in danger that we feel our body as our own. I defend a weaker conception, according to which it suffices that it has been in danger at some point to set up a specific valence to the boundaries of the body. Arguably, there is a stage in development in which it is important, possibly even necessary, to experience pain (or other affectively-loaded bodily sensations) in order to give affective significance to the boundaries of the body, a significance that is at the origin of the sense of bodily ownership. In short, past experiences that the boundaries of the body could be at risk make these boundaries the boundaries of the body that we experience as our own now.

To conclude, to fix the boundaries of the body that one feels as one's own, one must answer two questions: (i) where does the body stop, and the rest of world start? and (ii) what matters for self-preservation? I have suggested that touch primarily answers the first question, whereas pain primarily answers the second question.

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