## THE DUAL STRUCTURE OF TOUCH:

## THE BODY VS PERIPERSONAL SPACE

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Peripersonal space is space defined by the reach of our limbs and the tools that we hold in them. It is the territory of direct intervention—the area where we probe and shove, the zone of the head-butt and the cross-check. By the same token, it is where others intrude with *their* bodies, the locus of greatest vulnerability. Michael Graziano (2018: 1) memorably calls it the “margin of safety, bad breath zone, duck-and-flinch buffer.” Peripersonal space is, in short, where touch meets the Other, the region where self and non-self meet.[[1]](#footnote-1)

The skin forms the inner limit of peripersonal space. Our touch receptors reside there, and what we know by touch about peripersonal space is projected from the stimulation of these receptors. There is, however, a radical difference between feeling on the skin—*tactile sensation* (T), as I will call it—and *haptic perception* of things outside (H). One important difference is that tactile sensation is felt to be private and subjective—it’s awareness of things none but the subject can feel—while haptic perception delivers objective awareness of things outside—things like the pencil in your hand and the breeze playing on your face. Another difference is that (as I shall argue) haptic perception represents peripersonal space, while tactile sensation is not genuinely spatial. I will argue that as a consequence of these differences, haptic perception is not (as some have said) merely a reformatting of tactile sensation. Rather, it provides different information and is genuinely emergent.

#### Introduction: The Self and The Other

Here are two sensory events:

(T) In the darkness of early morning, I reach out to turn my phone-alarm off, and I bump against the corner of the table. I feel a sharp *thwack* on the back of my hand. This is a tactile sensation*.*

(H) I reach past the edge of the table and grab my phone. I feel it vibrate in my hand. It is the phone that I feel vibrating, not my hand. This is haptic perception.

These are complex sensory events. In both, there is awareness of the body as well as of something outside. In T, however, I am aware of something that happens to me in a way that I know nobody else can feel. In H, by contrast, it is an external object I feel—something I know you could feel as well. It is these kinds of sensory events I will be discussing—one is internally and the other externally directed. My aim is to show that there are two different sensory events here, existing side-by-side—the difference is not merely aspectual; it is not just a shift of attention between two ways of regarding the same data.[[2]](#footnote-2)

As mentioned earlier, there are two crucial differences between T and H.

The first difference is that T is *phenomenal* and *immanent.* The felt characteristics of the thwack on the back of my hand—sharpness, painfulness, transience, etc.—are qualities of my experience. By contrast, H reveals *objective* and *transcendent* qualities of *the phone*. The vibration presents itself as an event that exists outside my body independently of anything I feel. It’s possible that in fact the phone is *not* vibrating—that this is some kind of illusion. But the sensation produced by the *thwack* cannot be other than how it feels. However gentle and lingering the contact might actually have been, the experience itself was painful and punctate—I cannot be wrong about this.

The second difference has to do with *position*. The thwack is anchored to a body part; when I move my hand away from the point of impact, the pain stays exactly where it was—on the back of my hand. I do not feel it moving. Thus, I do not feel it as occurring side-by-side with things in the material world; the pain is not in extra-bodily space. The phone, by contrast, is (at least normally) experienced as located in external peripersonal space. Its location is sensed relative to my hand, of course, but additionally it is felt to be spatially related to other things that I see and feel near the point of contact. It’s felt to be on the table, next to the bed, etc.

These points are together suggestive of Kant’s dictum that space is the form of outer appearance:

*Transcendence of Peripersonal Space* We (tactually) experience something as existing outside the body and as the locus of objective (tactual) qualities when, and only when, we perceive it as located in space.

In short, touch represents something as distinct from the body by locating it in peripersonal space. H-perceptions are sensory presentations of things that exist independently of ourselves, in external space. T-sensations are felt to be private episodes that others cannot literally share, and they are not felt to occur in external space.

I’ll proceed as follows:

In Section I, I’ll explain how bodily awareness by touch, T, is qualitatively and phenomenally different from touch-experience of things outside, H.

In Section II, I will argue that these states are distinct: T ≠ H.

Finally, in Section III, I will argue that T is non-spatial, while H is spatial. T reveals position in a body-map; H refers an object to a location in peripersonal space. I’ll explain how these are different.

### T vs. H: Qualitative Differences

#### I. 1 Two Touch Experiences

Here are two examples that illustrate in more detail the different uses to which we put T and H.

*The Art of the Spin Bowler* You are a bowler in a game of cricket (or a pitcher in baseball). You want to deliver a ball to the batsman with a finely controlled trajectory. You must grip it in a very precise manner, so that at the moment of delivery, you can use the stitching on the ball to impart spin. In order to control this, you focus on the feelings of pressure that the seam of the ball exerts on your fingers. You make sure that there is a steady feeling of resistance on the first knuckles of your index and ring fingers—“not too light, not too tight,” as bowlers say. This is something touch tells you—what is happening at and near the surface of specific body parts. This is an employment of T: *tactile* sensation or feeling.

*The Guitarist’s Technique* Now think of plucking a string on a guitar. A guitarist’s aim is to create a certain effect on the string. Her effort depends on feedback she receives from the string—where it is, how tight, the angle of her finger relative to the string, the motion of the string relative to the body of the guitar, and so on. In short, she has to be aware of the string. Touch provides this awareness. Of course, the guitarist may also be conscious of feelings on her skin: if she had a cut or an abrasion, for example, it may sting. But to pluck the string with exactly the right amount of attack, she must be aware of how she is affecting *the string*. Here, the primary object of awareness is an external object; the focus is not on the body. This is H: *haptic* perception.

T monitors the skin (and sometimes areas deeper down in the body) *as a part of the body* (Mattens 2017, Mandrigan forthcoming). de Vignemont and Massin (2015) say that it is awareness of *pressure* due to the resistance that the body offers to, or exerts on, an external object. I am inclined to consider T more broadly, including distinct sensations of weight, torque, stretch, and temperature which is a distinct system[[3]](#footnote-3)—and of pain as it relates to all of these. The important point here is that T is, in the sense explained in the Introduction above, *phenomenal* or *immanent*. The qualities just mentioned—pressure, twist, stretch, temperature, etc.—are given phenomenally, i.e., as qualities of the experience itself.

H has different content; it informs us about the qualities and locations of external objects that are in direct or indirect contact with the body. It’s not, as such, about the body—the term ‘perception’ marks awareness of something distinct from the subject herself, or her body. The qualities that H presents are attributed to things outside the body, in peripersonal space, and not to the experience itself.

It’s important to note that (a) both T and H are mediated by the same cutaneous receptors, but, as we shall see, (b) H requires something more.

#### I.2 Proximal vs Distal in Touch

In perception generally, external stimuli bring about two distinct experiences, one *proximal* that reflects the state of the sensory receptors when the stimulus registers, and a distinct *distal* experience that reveals properties of the external object of perception. Colour perception is a good example: proximally, it corresponds to the total effect that illumination and object-properties have on the retina; distally, it corresponds to the reflectance or brightness of an environmental object.[[4]](#footnote-4) White skin looks white even when it’s viewed in the green light that filters through tree cover; but if you attend closely enough, you can notice that a greenish tint in the highlights. Visual size perception is another example: proximally it corresponds to the angle that an object subtends at the retina; distally, it corresponds to the size of the object itself. Often, the *proximal* experience is in the background and requires an act of deliberate attention, while the distal experience is foregrounded in consciousness. For example, the screen on my table looks a lot smaller than the buildings outside my window, but with a deliberate act of attention I am able to see that they take up similarly sized regions of my visual field.[[5]](#footnote-5)

The proximal/distal distinction is also operative in touch. Here, T is proximal; it is an integrated construct of the response-levels of cutaneous receptors. H, by contrast, is distal; it reflects the properties of external objects despite the very different effects they might have on the skin in different situations. For example, a hard surface appears hard despite the fact that one feels it through a layer of foam—the tactile feel on the skin is different through foam; nevertheless, the object haptically appears to be hard, just as it does when it is touched without the foam. Most observers are primarily aware of the distal features of things they touch; it takes a deliberate switch of attention to focus on how the feel of the hard surface is a combination of its own hardness modified by the squishy admixture of the foam wrapping.

The unique feature of this duality in touch is that the proximal and the distal are differentiated by *location*.Tactile sensation is “about” the skin—more or less where the receptors are—while haptic perception is of things that are felt to be outside, though in contact with, the body (or a tool that the subject uses to probe something at a distance). In vision, by contrast, proximal and distal colour are co-located: both appear to belong to an external object of perception. Even when we attend to the colour of the light that an object is reflecting, as opposed to the colour of the object itself, there is no shift of location. An experienced photographer might notice the greenish tint of white skin under leaf cover—but it’s still the skin that looks greenish when she switches her attention in this way. We *don’t* ever sense proximal colour as located in ourselves—on the retina, for example.

This difference between touch and vision yields a significant preliminary conclusion. Think again of that pale-skinned person under leaf cover. At first glance, her skin looks the same as it does indoors in tungsten lighting of comparable brightness—that is, it looks white with a slightly pinkish cast. But looking more carefully, the photographer notices the tint produced by the leafy filter—this is apt to affect the shot she wants to take. In cases like this, her scrutiny does not shift to a different visual state. She’s still looking at her subject’s skin. Moreover, you could argue, the greenish tint was visible in the original viewing, though it was attentionally disregarded in favour of the more stable object-property. There’s reason to think that there is only one colour-visual state here, not two, and that the photographer’s view is simply a shift of scrutiny.

With touch, matters are not so obvious. The proximal/distal shift has much greater import here. T gives information about one object—the skin—and immanent qualities like resistance, warmth, etc., while haptic perception gives information about external objects and their transcendent qualities. There is reason here to suspect something more than a merely attentional shift between different aspects of the same experience. *Prima facie*, at least, these are two different experiences because they present states of different objects.

But there’s another side of the argument. Corresponding T and H states are simultaneously *available*, but typically you can attend to only one of them at a time. That is, if you attend to the feeling on your skin, you are less able to attend to the external object that produces that feeling, and vice versa. This leads some to say that the difference between T and H is *merely* attentional, i.e., that it is merely a matter of what you attend to in one and the same underlying perceptual state. I disagree with this, and in the next section, I will argue for the idea that T- and H-states are distinct. In other words, I’ll argue that:

T ≠ H.

### Not One, But Two

#### II.1 H and Trace-Integration

Now consider two touch-events.

*1. Spilled Liquid* (T→H) You are on a flight, absorbed in your book with a drink on the tray-table in front of you. Suddenly, the plane hits a bump, and you are startled by liquid splashing on your hand. At the very first instant, your experience is purely tactile; you feel an impact on your hand (T). But then the liquid trickles down the back of your hand and wrist, creating a coordinated train of sensations. Now, you become aware of cool liquid trickling down the back of your hand and beneath your sleeve (H).

This sequence of events suggests that H emerges by integration of the temporal succession of T—over the time-period in question, T has traced a continuous path on the skin. Vision can play a role here: if you happen to see the liquid splash, you may immediately feel it as an external object (H) by integration of the visual and tactual inputs.

And here’s the second event:

*2. Pins and Needles* (T-alone) You are in a cramped airplane seat and you get “pins and needles” in your foot. These prickly sensations seem to dance about, but there is no feeling of externality. The sensation is internal all along.

What is the difference between these felt experiences? It is that in the first more common kind of case, the touch-system finds a continuity in the train of T-sensations that indicates the motion of an external object against the skin. In pins and needles, the train of sensations dances randomly over your foot in a manner that cannot be ascribed to an external object. The sense of touch integrates the first: thus T→H. But it is unable to integrate, or “make sense of,” the second; thus, T-alone.

The idea of T-alone has been overlooked. de Vignemont and Massin (2015) claim that one seems to feel something outside when there is resistance to pressure that one exerts. They write: “in order to feel the resistance of the external world, we have to be aware that it exerts some force counteracting the force we are intentionally exerting on it” (*ibid*, 301). I agree with this as far as it goes, but it does not say how the activation of cutaneous touch receptors can yield awareness of a counteracting force from the outside. And because it does not address the emergence of H, it overlooks passive H—sensations of external pressure in the absence of force intentionally exerted in return. The awareness of liquid trickling down my hand is an example—I don’t exert force on the liquid; all the same, I feel it exerting force on me. You feel the shirt on your back, but you don’t exert any force on it. Thomas Reid gives another interesting example: a “scirrous tumour” under the skin that creates (according to him) the impression of an external object without reciprocal effort.

It is important to appreciate that H-awareness of an external object is something more than T-awareness of pressure over a contiguous and segregated area of skin.[[6]](#footnote-6) That is: H ≠ {T} (where {T} denotes some collection of T-sensations). Let me make an additional point about this by considering how the closely related sub-modalities of warmth and pain are different in this respect. These sub-modalities deliver T-sensations to the skin. When I sit before a fire, contiguous parts of the skin on my face feel warm; when I feel the itch of a rash on my forearm, I am aware, similarly, of a segregated area of qualitatively homogeneous T-itch-sensations. But there is no awareness of an external object in either case (Cataldo et al 2016). Add pressure-touch sensations, and H-perception emerges—but only if there is trace integration of T. When I hold a warm cup in my hand, or when my arm is abraded by brushing up against a rough wall, I feel similar contiguous skin-located T-sensations of heat/pain. But in these cases, I am also H-aware of an external object. The difference is pressure-touch: when it is trace-integrated, it affords awareness of something outside. This shows how H is more than contiguous {T}.[[7]](#footnote-7)

To summarize: H emerges from the trace-integration of pressure T.

#### II.2 Immanence (T) vs Transcendence (H)

The idea of T alone is, to some extent, an idealization. Almost always, the touch-system is able to assign an external cause to tactile stimulation and thus to produce T→H. And (as we shall see) this has led some to say, introspecting their experience is such “normal” cases, that the difference between T and H is merely an attentional switch. When you grip the ball, you can attend to the feel of the stitching on your skin, or you can attend to the properties of the ball. Similarly, when you pluck the guitar string. Is there just one touch-state here, within which you switch your attention from one aspect to another, or are there two? To help answer this question, let’s examine the states themselves more closely.

Thinking, then, of T-states, one striking characteristic is what I have called *immanence*—the quality of which we become aware in a T-state is a quality of the experience itself. Consider two different T-feelings: an itch and a gentle tickle. Each of these experiences has a characteristic “feel,” or phenomenal quality, that identifies its kind. An itch is an itch because it feels like an itch; it is different from a tickle because it feels different. There is nothing more to be known about this; an itch is not what it is because (for example) it represents the secretion of a histamine; it is the kind of state it is because of how it feels. Similarly, it is not different from a tickle because its physical causes and internal processing are different, but because it feels different.[[8]](#footnote-8)

By contrast, think of H-perceptual states. Let’s say you have two objects in your pocket: a pen and a key. You can identify them, without looking, by feeling their shapes. There is no one tactile sensation that is associated with each shape: you may feel them from different directions, with different parts of your hand, through wool or through silk or directly. It takes a certain amount of tactual exploration to determine their shapes and thus to identify them, but each exploratory episode might be radically different from another. There is no one phenomenal quality associated with the perceptions of the same quality, whether it be shape or texture or temperature. The content of these haptic states is not defined by their phenomenal feel, but rather by the shape that is revealed. H-content is *transcendent*.

#### II. 3 T-Location and H-Location

There is nothing more to the *kind* of a T-state than its phenomenal character. But you can be subject to many T-states of any given kind. After walking in the Canadian woods on a summer’s day, you may have been bitten by mosquitos all over your hands and neck, and you may thus be plagued by many itchy experiences of the same phenomenal quality. What distinguishes these is that they are “in” or “on” different parts of your body.

Now, to say that an itch is “on” a part of your body, say your forearm, needs some explication. Itches, being experiences, do not literally reside on parts of the body; an experience is not felt to be located on or in a body part in the same sense that I am *on* a bus *in* Toronto. The body part is, in some sense, a locator, but not in the sense of a spatial region that contains a material object—a sensation is not the kind of thing that resides in a spatial region. Experiences are rather “referred to” these bodily locations; they draw sensory attention to them and make them the targets of action. An itch asks for a certain part of the body to be scratched: this is what it means to say that it is “in” that part.

An individual T-sensation is one that has a certain phenomenal quality referred to a certain bodily part. (Here I mean quality to include intensity—a mild itch is qualitatively different from an unbearable itch). A bodily sensation (such as an itch) is numerically different from another bodily sensation of the same phenomenal quality when and only when it is referred to a different body part. We can sum this up by defining a T-sensation as an ordered pair, <*Q*, *p*>where *Q* is an immanent phenomenal quality *Q* and *p* is a part of the subject’s body.[[9]](#footnote-9)

What is the relationship between the body part *p* and a location in external space? I will be discussing this question in more detail in Part III of this paper, but for the moment let us note that the answer is far from obvious. I am sitting on a bus and I feel the seat behind me. At the same spot where the seat touches me, I also feel an itch where the wool of my sweater rubs against my back. Yet, I don’t feel the itch to be *in the same place* where the seat of the bus is—they are not co-located. The bus seat is *in contact with* my back but distinct from it. Further, my awareness of where the bus seat is integrated with my awareness of my own body—I can distinguish its motion from mine. Here is the conclusion we can draw from this: T (the itch) in body part *p* and H (awareness of something external) at body part *p* do not together imply that T and H are at the same location. This shows that body parts play different localizing roles in T and in H. In awareness of the bus-seat, the spot on my back is (as I will explain more fully in the following sub-section) a *pointer* not a direct locator. [[10]](#footnote-10)

How does information about the bodily location of the pressure yield information about external space? Trace-integration is only part of the story. Let’s call this the Space-Mapping problem.[[11]](#footnote-11)

#### II. 4 Haptic Content

Now, consider the individuation of H-states. As noted earlier, they are presentations of the transcendent qualities of external objects. The cup in your hand is smooth, hard, and warm. These qualities are not exhausted by experiences that you undergo; they are qualities of the cup that persist through changes in your experiences that occur as you shift your grip on the cup.

Now, just as in the case of T-states, it is possible to have two H-states that are about the same quality. You may hold a cup in each hand, compare their touch-qualities, and find that they are the same. And as with T-states, the things you haptically perceive are differentiated by their location relative to your body—one cup is in your right hand, the other in your left. However, the transcendence of the qualities makes for some important qualifications here.

First, a quality like hardness is felt to be *external*. We noted earlier that tactile sensation isn’t literally located in a part of the body; it is simply “referred to” it—that is, it draws attention to this part of the body, or prompts behaviour directed to it. But a quality like hardness is felt literally to be located in a place identified by a T-sensation. You experience a feeling of pressure figuratively “in” your hand; thereby, you feel something hard *literally* in your hand.

Technically, this can be expressed as follows: the body part in which you feel a sensation of pressure becomes a *pointer* to a region of space adjacent to the body part in which you perceive something hard. Define *T-spatial representation* as a coordinate system defined by such body-centred pointers. The question is: How much does T-spatial representation tell you about external space? This is analogous to the Space-Mapping problem mentioned at the end of the previous sub-section. How much information about external space is implicit in the pointer from a (subject-indexed) body-part?

Second, transcendent qualities like hardness are ascribed to external *objects*—not just to spatial regions but to objects that reside in those regions. In your hand, you feel a gift-wrapped object that is hard *and* smooth *and* warm. In exactly the same part of your hand, you feel the soft cloth that’s wrapped around the gift: it is also warm, but its warmth is a distinct thing. In such a case, you feel two things among which these qualities are apportioned; the qualities are not merely co-located in the space around your hand, but ascribed to different objects.[[12]](#footnote-12) This kind of co-ascription doesn’t arise in tactile sensation. A feeling of pressure on your hand is different from a feeling of warmth in your hand; neither is a quality of your hand—they are positionally co-referred to your hand, but distinct. This is a crucial difference between T- and H-states: in haptic perception, qualities are felt to belong to *objects* that are differentiated both from the subject’s own body and from each other.

Let’s sum this up in this way:

*Feature Binding in H* H supports feature binding to objects; T supports only feature location relative to parts of the body.

Putting this together, we may conclude that haptic perception has content that is more complex than tactile sensation. With pins and needles, you simply feel <*Q*, *p*>, a tingly sensation in your foot. With the spilt liquid, you feel warmth (*Q1*) and motion (*Q2*) ascribed to an object *O* (the liquid) in a pointed location *p↑*(the region of external space just beyond the back of your hand). Thus, H-perceptual states take the form <{*Qi*}, *O*, *p↑*}, where one or more qualities *Qi* are ascribed to an object *O*, in a spatial location identified by a pointer from a bodily part.

I will end this section by noting a significant detail that figures in the not-one-but-two argument of section II.6 below. We feel things by touch not only by touching them with our body, but also by touching them with tools or other manipulatable objects. For example, I can perceive the texture of a sheet of paper both by stroking it with my finger and by writing on it with a pen; I can test the give of a soft object directly and also indirectly, using a stylus or pincers. When objects are probed at a distance, they produce tactile sensations as well as haptic perceptions. With respect to the latter, they are felt to be located not at the skin but at a distance, at the end of the tool. The body-part *p* referred to by a sensation need not be spatially next to the location *p↑*that it points to, though it often is.

#### II.5 The Non-Supervenience of the Haptic

We have been considering trains of tactile sensations that result in a perception of an external object when the touch-system can “make sense” of them. It is notable that this involves a form of perceptual constancy. The spilt liquid courses down the back of your hand and up past the cuff of your shirt. Through the array of tactile sensations that result, there is a single perception of a rivulet of sticky liquid. Many sensations, one perception: different T, same H.

Equally, the same tactile sensations can lead to different (or no) haptic perceptions. Go back to the case of the spilled liquid. Consider the first moment after the splash. You have no perception of something outside you—just the feeling of something happening to you. But if that very sensation had been embedded in a temporal sequence, it might have produced a perception, and the content of that perception would depend on the character of the other components of the sequence. The “cutaneous rabbit” (Geldard and Sherrick 1972) illustrates this. Deliver five brief mechanical pulses (2 ms each, separated by 40-80 ms) to the wrist, then 10 cm up on mid-forearm, and finally another 10 cm up near the elbow. The result is “a smooth progression of jumps up the arm, as if a tiny rabbit were hopping from wrist to elbow.” Slow the sequence down or make it less regular and the illusion is destroyed. Same T, different H. Or, again, consider tactual form-agnosia. E. C. was a patient who had suffered an infarction in the left parietal lobe. The result in her case was a significant impairment of object recognition by touch, though other haptic capacities were spared (Reed and Caselli 1992).

Tactual form-agnosia is particularly significant because it establishes a connection with visual form-agnosia, in which patients lose the ability to recognize, or even see, shapes despite retaining visual acuity. In vision-studies, it is standard procedure to construe agnosias of all sorts to be failures of *perceptual* (as opposed to post-perceptual or cognitive) mechanisms. The parallel with visual form-agnosia strongly suggests that though tactual form-recognition is temporally extended, it is nonetheless perceptual in nature. The same is true of the cutaneous rabbit (above): it is strongly analogous with phenomena surrounding the visual perception of motion, for example, the *φ*-phenomenon. (See Reed, Caselli and Farah, 1996 and James, Kim, and Fisher 2007 for further discussion of parallels between visual and haptic perceptual processing.)

These observations demonstrate a double dissociation between the tactile and the haptic.

Lemma 1: You can have *different* proximal stimulations/tactile experiences (T) with the same haptic perception (H) arising. (Cutaneous rabbit illusion vs a real rabbit hopping up your arm.)

Lemma 2: You can have the *same* proximal stimulations/tactile experiences different haptic perceptions arising. (Tactile form agnosia vs unimpaired subject.)

Conclusion: Haptic perceptual states are *distinct from* (collections of) tactile states.

#### II.6 T vs H: Not One But Two

Developing a line of thought originated by Brian O’Shaughnessy (1989), M.F. Martin (1992) talks about touching the rim of a glass and being aware both of pressure on the skin and of the glass—these are not two but one, according to him. Martin writes:

We should think of this case **not** as one in which we have **two** distinct states of mind, a bodily sensation and a tactual perception, both of which can be attended to; **but** instead simply **one** state of mind, *which can be attended to in different ways*. One can attend to it as a bodily sensation—in which case its spatial character reveals the location of sensation—or attend to it as tactual perception of something lying beyond the body but in contact with it, so that the spatial character is that of the location of whatever it is which connects with and impedes the movement of one’s body. (Martin 1992, 204. Emphasis added to highlight the not-two-but-one thought.)

According to Martin, the bodily sensations caused by tracing the rim of a wine-glass are one and the same as the perception of the wine-glass, an external object. There are not two states here, but only one attended differently. In other words, T=H. And he makes the further claim is that the awareness of a bodily part implicit in tactile sensation is simply the same as awareness of a spatial location. But this simply overlooks the Space Mapping problem: to talk about the felt spatial location of sensation simply overlooks the fact that sensations are not felt to be spatially co-located the external things we feel—the feeling I have on my fingertip is not felt to be on the rim of the wineglass I happen to be touching.

Let me make a brief comment about this that I’ll take up in more detail in section III. O’Shaughnessy and Martin are talking about a situation in which the subject is *acting*—tracing the rim of a glass in the above example. In such situations, kinesthesia provides sensory input that supplements tactile sensation, and awareness of external space ensues from the enriched sensory basis. So, it is not quite correct to say (as Martin implies above) that this example of awareness of “something lying beyond the body” is a bodily sensation (i.e., T) in the sense that concerns me.[[13]](#footnote-13)

#### II.7 Summary

The preceding discussion provides strong—I would say conclusive—reasons for rejecting the not-two-but-one idea.[[14]](#footnote-14) Drawing them together:

* 1. *The Emergence of the Haptic* The contrast between the spilt-liquid and the pins-and-needles cases shows that something more than T is needed for H. I argued that this “something more” is trace integration to diagnose an external cause for the train of tactile pressure-sensations.
  2. *Non-Supervenience*: No T-set is either necessary or sufficient for any given H.
  3. *Transcendence of the Haptic* Tactile sensation is quality-wise immanent; the quality presented in T is a quality of the T-experience itself. In haptic perception, however, the quality revealed is that of something that is presented as existing independently of the subject.
  4. *Externality of Haptic Location* In the train of the difference regarding transcendence, the kind of location presented in T is different from that presented in H: T-location a bodily part; H-location is spatial. (I’ll say more about this in Part III.)
  5. *The Spatial Mapping Problem*: Even when T (e.g. a feeling of pressure on the finger) arises from an object that the subject touches and H-perceives (e.g. the rim of a wineglass), T is not felt to be located on the external thing. (The feeling of pressure on my finger is not felt to be on the wineglass that I am touching.)
  6. *Distal Location in Tool Use* The spatial location indicated by H isn’t always adjacent to the body-part referred to by the corresponding T. We feel things at the end of tools, but of course tactile sensation is always on the skin (or apparent skin, in the case of amputees who suffer from phantom-limb syndrome). This shows that spatial coincidence is not mandatory.
  7. *Feature-Binding* H-qualities can be co-bound to the same object. The cup in my hand is warm and curved and smooth. T-qualities can be co-located but not co-bound: I may feel warmth and itchiness at the same spot of my forearm, but these are not properties of my forearm.

Thus: H ≠ T.

### Spatial Representation

#### III.1 Bodily Position vs. Spatial Location

Having argued for the distinctness of T and H, I will now argue that T is non-spatial while H is spatial. Recall, however, that I have been saying that T is referred to a bodily position. I will now explain why the bodily-positional content of T is not spatial, or at best only sparsely spatial.

Think of a dispatcher who is in charge of a number of taxicabs; she has information about who is driving each, and whether it is taken or empty. She knows, for example, that Anil is driving Car 1, which is currently empty, and that Barbara is driving Car 2, which is taken. This is *positional* information about the two drivers—they are in Cars 1 and 2. But it does not tell her *where* in the city Anil is or how far from Barbara—the dispatcher has no explicit *spatial* information.

Still, she can make a few simple inferences. Right off the bat, she knows that Anil is in a different spatial location than Barbara—they’re in different cars, and cars don’t overlap spatially. This is what we might call *background information.* And the drivers’ occasional reports tell her more. Anil reported ten minutes ago that he was dropping a passenger off at Union Station; Barbara said five minutes ago that she was at the airport. Since the dispatcher knows where these landmarks are, she can figure out the minimum and maximum distances between Anil and Barbara. We can call this *update information.* As time passes, update information degrades; the taxis are constantly moving and update information from an hour ago tells us little about the position of the cabs now.

A spatial representation consists of a set of points, or locations, and certain metrical relations among these points—canonically these relations will include or imply distance and direction. The taxi-dispatcher has a representation of a certain set of locations—the cars and some of their non-spatial properties. But she knows little about the distance and directions of one location to another. She can make certain inferences from other information, but since the locations move about both in space and relative to one another, background information is sparse and update information constantly degrades and must constantly be renewed.

Like the taxi dispatcher, touch is poorly informed about space. Cutaneous receptors are embedded in a body map consisting of minimal bodily locations—little bits of skin within which distinct positions cannot be discriminated—tactile receptive fields, or RFs, as they are called. And we can assume that the system is so constructed as to take advantage of constant background information. For example, some of the RFs are at a fixed distance from one another—RFs on a single non-deformable part of the body, such as the forearm or the back of the head, are same-sized. And there are certain limits on distance that follow from body-size. But information about space is generally changeable. For example, feeling a touch on your finger and another touch on your shoulder doesn’t suffice to tell you how far apart the two touches are, because your finger moves in space relative to your shoulder. Here, update information is needed—information provided by the proprioceptive sense, not by touch. As in the case of the taxis, background and update information provide some clues as to spatial relations. But it is worth noting that update information is generally provided by senses other than touch, specifically proprioception, kinesthesis, and (crucially) vision.

In peripersonal space, in particular, vision and proprioception (or awareness of bodily position) work together with touch to construct awareness of spatial location. You experience a prick on your finger; you can see that the finger is in contact with a needle on the table. Consequently, you know that the prick on your finger (positionally identified by touch) is caused by an object on the table (spatially located by vision)—you are able, for instance, to use your other hand to move the needle away. Interestingly, it has been found that neurons that encode bodily position in the motor areas of the brain are sensitive to visual experience of those bodily positions (Brozzoli, Ehrsson, and Farnè 2013). In the case just mentioned, the neuron that records cutaneous stimulation of the finger is activated also by visual information that records objects near the finger. These bimodal neurons provide a link between bodily position and peripersonal space. However, it is unclear *how* the link is computed or maintained. How does the brain collate tactile information with visual?

### Reid’s *Experimentum Crucis*

Thomas Reid posed a classic, and as yet unsolved, problem for the idea that T is spatial. Imagining a blind man who “by some strange distemper” had lost his conception of extension and space, Reid writes:

Suppose . . . that a body is drawn along his hands or face, while they are at rest. Can this give him any notion of space or motion? It no doubt gives a new feeling; but how it should convey a notion of space or motion, to one who had none before, I cannot conceive. (*IHM* 5.6)

Reid thinks that this thought experiment demonstrates that touch sensations lack spatial content.

Now, before we can properly assess this argument, we must take note of the anchoring of tactile sensation to bodily position. On any part of the body, there is a minimum distance, *d*, between two points on the skin such that two simultaneous stimuli separated by *d* can be discriminated at two—two stimuli separated by a shorter distance feel like a single stimulus. This distance *d* is known as the *two-point threshold­*. (The value of the two-point threshold is different in different parts of the body—we’ll come back to the importance of this point in the following section.) We can imagine that the skin is divided into little cells, or RFs, each constituting one minimal part of sensitivity—the size across an RF is, in other words, equal to the two-point threshold for that part of the body. We called these cells *receptive fields* or RFs. The RFs are units of bodily position.

Consider, then, Reid’s blind man who has no conception of extension or space. Somebody strokes his face. As they do so, he experiences a brief stimulation of one RF and then another and then another. Reid’s claim is that this succession of sensations does not “convey a notion of space or motion.” Is this credible?

Go back to the case of the taxi dispatcher. Suppose that she has a list of positions that the taxis could occupy: call these A, B, C, etc. These are her RFs. She also knows (as background information) that in order to be at A and then later at C (or vice versa) you have to be in place B at a time in between. Now suppose she finds that Car 1 reports being in place A, followed by place B, followed by place C. Can she abstract from this information a “notion of space or motion?” No, because she has no information about distance or direction, or about the trajectory of the car. AB could be a lot shorter than BC; it could be at right angles; the driver might have been driving faster along BC, etc. In short, in the absence of further information about the relationship of the “places,” the dispatcher might know that a car has changed places, but not know how far or in what direction it has moved. This, in essence, is Reid’s point.

Now, of course, the touch-perceptual system may possess a good deal more background information than our taxi-dispatcher. Nevertheless, it is instructive to note that its information is limited. Consider:

1. If somebody draws their finger along your nose, you experience a sequence of tactile sensations (T), but gain no information about the shape of your nose. Yet, if you were to trace your nose with your finger (H), you would feel in your finger the shape of your nose.
2. Suppose a liquid was intravenously injected along your femoral vein, and you feel the coldness (T) coursing from groin to toe. You could not tell from the progress of the disturbance whether your leg was bent or straight. Yet, if you traced your leg with your finger (H), you can easily gain this information.
3. If a small vibrator is securely attached to your finger and turned on (T), it feels stationary even when somebody (including you) moves your hand or finger.
4. If two small vibrators are attached, one to your forearm and the other to your ribcage on the opposite side, you cannot tell which one is higher from the ground.

1 and 2 are cases in which T contains less spatial information than the corresponding H, while 3 and 4 are cases in which T lacks some spatial information (though the equivalent H might also). Update information could, of course, be added to these cases and this might be sufficient for spatial structure. But as we have seen, this information may come from modalities other than touch.

I conclude from the above that, at the very least, Reid is correct to say that T lacks some of the structure that we would expect in a spatial representation.

### Receptive Field Path-Integration

Now, despite the examples just presented, it seems that even though T is deficient in its representation of space, it is not entirely lacking in it. For it’s hard to deny (though Reid seems to) that when somebody draws their finger along your nose or face, you experience something like motion. Such an impression requires, at the very least, some awareness of adjacency relations and of direction. In Figure 2, the impression of motion demands that the touch-system is able to determine not only that certain receptive fields, or RFs, are activated in sequence, but that the second is adjacent to the first, and that the third continues on, and that there is a reversal of direction at the third RF, etc.[[15]](#footnote-15)

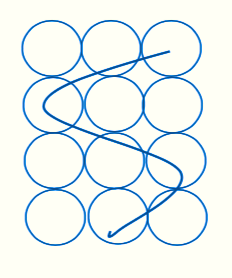


Figure 2 An S-shaped tracing across the skin

Where does the awareness of these relations come from? Is it innate in touch? Or does it require input and calibration from other sources, particularly vision, proprioception, and kinesthesia? A full discussion of this question goes beyond present knowledge—and certainly beyond the scope of this paper—but I’ll conclude with a brief overview.

Fardo et al (2018) investigate passive S-shaped tracings on the back of the hand. They asked participants to bisect the distance between the start and finish locations of the tracing—i.e., the (unstimulated) midpoint of the straight line that joins these locations. Subjects were found to be successful in identifying this midpoint, with a slight bias towards the larger half of the S (in cases where the shape was not symmetrical from top to bottom). The task requires an integration of the back-and-forth movements of the tracing to yield the direct line from start to finish. The authors write: “Our results are consistent with a path of tactile path integration that constructs a RF-based organization of ‘skin space’” (241).

Now, this is an impressive conversion of bodily position (the RFs) to spatial measurement (the bisection task). But the experiment is conducted under two special constraints. First, the tracings are all along the back of the hand and spatial discrimination is constant within this area—that is the size of the RFs is the same throughout, and RFs can function as a proxy for distance. As well, the speed of the tracing was more or less constant. Thus time elapsed between one RF and the next serves as a proxy for speed.

The question to ask is: What would happen if the tracing crossed over into an area where sensitivity was different—across the wrist line, for example, or over into the torso with the hand held adjacent? Then we would have a tracing more like Figure 3. If it assumed equal size, the touch-system would come up with a midpoint that is biased toward the more sensitive region. For a successful bisection in this scenario, therefore, the perceptual system would require information about the size of different receptive fields. Where would this information come from?

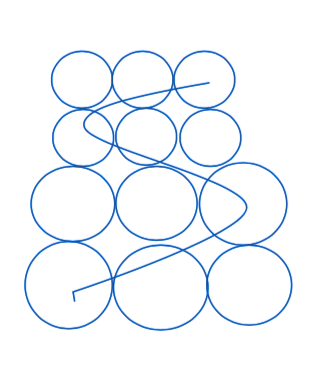


Figure 3: A S-shaped tracing over areas of differing spatial resolution

In personal correspondence, Patrick Haggard suggested the following two possibilities, which I have embellished somewhat.

A. The system could calibrate the size of receptive fields by assuming constant speed for any given moving stimulus. A simple strategy of this sort would predict some wrong answers because obviously some stimuli do not move with constant speed. But a somewhat more complex strategy could calibrate RF relative to some subset of stimuli. However, the most obvious strategies of this kind would involve self-awareness: some stimuli are likely to be moving with constant speed when the subject herself is moving with constant speed, since then anything that she brushed up against would satisfy the condition. But this restriction involves self-awareness through a non-touch modality. Moreover, there is good reason to think that the touch system makes systematic errors across areas of differing spatial discrimination.[[16]](#footnote-16) So it is doubtful that it successfully uses this method.

B. The system could use external measures to calibrate motion—specifically vision, proprioception, and kinesthesis. But this is, in effect, to acknowledge Reid’s point that touch by itself is incapable of genuine spatial representation.

The conclusion to be drawn from this section is that spatial representation across body parts is computationally difficult for the touch system, and though a constant speed assumption could help, it is both empirically dubious and somewhat implausible that this is the way the system actually works.

### Conclusion

Does pure touch represent bodily position non-spatially? The question can be reformulated as follows: Does haptic perception (which *is* spatial) take its spatial information from other modalities? I have offered two reasons for thinking that the answer to these questions is ‘yes.’ The first is phenomenological: it seems that we feel touch on our skins but not on objects in contact with our skin. The second is both neurophysiological: cutaneous response is anchored to minimal body parts, or receptive fields, and the spatial extent of these receptive fields varies across the body. Together, these considerations support the idea that haptic perception (H) is (contrary to some influential philosophical accounts) distinct from tactile sensation (T), and that H requires input from non-touch modalities. Since tactile sensation is experientially immanent, while haptic perception is transcendent, my argument is strongly suggestive of Kant’s thesis that things are presented as existing objectively when they are represented spatially.[[17]](#footnote-17)

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1. De Vignemont and Ianetti (2014) suggest that distinct maps of peripersonal space are used for the distinct functions of intervention and defence. This would fit within the quite coarse-grained treatment that I offer in this paper, which focusses on the difference between representations of the subject’s own body and of external objects in contact with it. [↑](#footnote-ref-1)
2. Fulkerson (2015), chapter 1, is an authoritative account of the difference between tactile and haptic. [↑](#footnote-ref-2)
3. Weight, torque, and stretch are pressure-related, but they feel different; the feeling of warmth arises from different receptors. [↑](#footnote-ref-3)
4. In audition, olfaction, and gustation, the proximal stimulus is an aggregate which in the distal stimulus is apportioned to different sources. For example, the proximal auditory stimulus is a frequency-power distribution that pertains to the entire scene. You can hear some aspects of this—for example, the harmonies played by distinct instruments in an orchestra—but the salient experience is generally of separate voices or sources, each with their own power distribution. Here, both proximal and distal experience is of things outside the subject—the whole ambient scene or individual voices within it. [↑](#footnote-ref-4)
5. Jonathan Cohen (2015) emphasizes this duality: perceptual constancy registers the sameness of distal properties while perceptual contrast registers differences in perceptual circumstances such as illumination, distance, etc. But he points out that the proximal and distal are often co-present—for example, when we see an object that is partly in shadow, we perceive both that the object is uniformly coloured and that some parts are brighter than others. [↑](#footnote-ref-5)
6. See Matthen (forthcoming) for an extended discussion of the same point regarding vision; visual awareness of a material object is different from visual segregation of a contiguous volume of space. [↑](#footnote-ref-6)
7. I am grateful to Patrick Haggard for alerting me to this difference between pressure-touch and warmth/pain. [↑](#footnote-ref-7)
8. My thesis about T-states may remind readers of a thesis about colour that Mark Johnston states this way:

   *Revelation*. The intrinsic nature of canary yellow is fully revealed by a standard visual experience as of a canary yellow thing.

   And I am indeed claiming that the intrinsic nature of T-states is fully revealed by what it is like to experience them. But there is a difference. Johnston’s *Revelation* purports to show how we come to know the essence of a quality, colour, that inheres in external objects. My thesis is that T-states do *not* reveal externalities; they are simply experiences of a certain kind. That said, my approach has some overlap with Johnson’s. He suggests that what we know in the case of colour is an experience that actualizes a disposition; my account of T-states is that they *are* experiences. [↑](#footnote-ref-8)
9. A sensation is indexed to the subject and would, in this manner, be *de se*. So, a fuller specification would be <*Q*, *p*, *i*>, where *i* is the subject.This is important for its role as a pointer to a location in external spaced, but I’ll ignore it for simplicity’s sake. (See the following subsection.) As well, *Q* is intensive, that is, it admits of more and a less. Some separate intensity from the *Q*, which would indicate a four-place specification, <*Q*, *I, p*, *i*>, where *I* measures the intensity of *Q.* [↑](#footnote-ref-9)
10. Frédérique de Vignemont (2020) defines peripersonal space as that region around the body in which space is multiply mapped relative to many movable bodily parts. I am sensitive, for example, to how far from my left index finger the ‘m’ key is, and I am also aware of how far from my right index finger it is. This is essential for communication with the motor cortex, for if I wish to touch the ‘m’ key with the left finger, I have to make a different motion than if I were to do so with my right finger. Far away objects pose no such problem of differentiation. They are represented, visually, as a certain distance away from *me*. [↑](#footnote-ref-10)
11. See Azañon et al (2010) for further discussion of Space-Mapping. Mandrigan (forthcoming) seems to overlook the difference between the T-map and the H-map and the allocentricity of the latter. [↑](#footnote-ref-11)
12. This contradicts visual field feature-placing theories such as those of Austen Clark (2000). See Matthen (2004) for discussion. [↑](#footnote-ref-12)
13. Alisa Mandrigin (forthcoming) makes the interesting claim that we don’t sense *bodily* location except when we act. In other words, her idea is that I know where my hand is relative to my elbow because I know how to reach for something by flexing my arm. Her evidence for this comes from certain dissociations between bodily awareness and action in both neurologically damaged and healthy subjects. However, these subjects are tasked with locating objects in external space relative to their own body parts. (Where is that object relative to your hand?) Her argument does not show anything about T as such—tactile sensation in the absence of action. [↑](#footnote-ref-13)
14. To be clear, I *don’t* deny that T and H may often be different stages of the same processing stream. My claim is just that they are different. This claim is particularly important for my treatment of the spatiality of H in section III. [↑](#footnote-ref-14)
15. Jean Nicod (1930) has a rigorous discussion of the requirements of such impressions of space and motion. See also Haggard et al (2017). [↑](#footnote-ref-15)
16. The question of pattern detection across different areas of the body was investigated (inter alia) by Haggard and Giavagnoli (2011), who report: “judgements about the alignment of tactile patterns spanning two distinct body parts were surprisingly poor” (*ibid.* 73). [↑](#footnote-ref-16)
17. I gave this paper to audiences in Antwerp and Paris, and received very helpful feedback, particularly from Pierre Jacob, Kevin Landy, and Gerry Viera (as well as from a number of other questioners whose names I don’t know). I am particularly grateful to Solveig Assen, Michael Barkasi, Jonathan Cohen, Becko Copenhaver, Matt Fulkerson, and Patrick Haggard for extensive comments on earlier written versions. I owe special thanks to Ophelia Deroy, and Frédérique de Vignemont for indispensable help with the structure of the argument. [↑](#footnote-ref-17)