# Spatial certainty: Feeling is the truth

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*Abstract*

Doubting Thomas, the biblical figure who could not be content with the mere vision of Jesus after his resurrection and asked to touch him, points toward a **seldom-discussed privilege granted to touch over vision.** Can we indeed identify such a privilege, and what does it amount to?

In the first part of the chapter, we show that the privilege granted to touch becomes puzzling once considered as a comparative and epistemic superiority, that is as touch being considered as more informative than vision although **the two modalities provide similarly accurate information about the same properties**, as it can happen for the existence as well as the spatial properties of mid-size objects. We show that this situation of equal accuracy, though difficult to assess in real-life situations, is not a mere ideal, as it can be implemented in laboratory settings. In a second part, we discuss the interpretations of this comparative tactile superiority.

Previous philosophical accounts tend to explain the privilege granted to the sense of touch for both existence and space at the level of perception itself, seeing it as more 'objective' or more directly in contact with reality. The novel account proposed here suggests that touch offers not a perceptual, but **a metacognitive advantage: touch is not more objective than vision but rather provides comparatively higher subjective certainty.**

The paper develops this account in three directions. First, we argue that conceptually, if not practically, we should distinguish two ways in which touch offers more subjective certainty than vision: one, which we call 'existential certainty', concerns the beliefs in the existence of their object, the other, which we call 'spatial certainty', concerns decisions about the spatial properties of objects. Second, we question whether this heightened certainty occurs across all cases, or more selectively, in particularly ambiguous or problematic cases. Finally, we consider candidate explanations of this metacognitive bias, coming from the richness, active character and developmental primacy of touch.

Keywords: Spatial properties, touch, vision, confidence, metacognition, perception.

“Seeing is believing, but feeling is the truth” Thomas Fueller.

“Art thou not, fatal vision, sensible
To feeling as to sight? “
Shakespeare, *Macbeth*, Act II, scene 1

We often forget that the proverb ‘seeing is believing’, originally from Thomas Fueller, is cited with an important concession: ‘Seeing is believing’ indeed, ‘but feeling is the truth’. Accepting that Fueller had in mind our sense of touch, rather than our hearts, he seems to remind us that when it comes to checking things in the world, touch seems to occupy a special role. It is the sense we turn to, like Macbeth, as if it offered a better grasp on objects or their properties than vision could. But why do we grant this privilege to touch? What does touch bring, that vision does not?

Macbeth’s appeal to touch comes as a way of ascertaining whether the dagger that has appeared in front of him is special. The hallucinatory nature of his experience however, makes this case special. For disjunctivists, certainly, the hallucinatory nature of the king’s experience is sufficient to make the case non-representative of perception. Disjunctivists indeed hold that perception and hallucination are separate kinds of states, and that the epistemic status of one does not compare to the other. To quote Paul Snowdon, “the experience in a genuinely perceptual case has a different nature to the experience involved in a non-perceptual case. (....) The experience in the perceptual case in its nature reaches out to and involves the perceived external object, not so the experience in other cases.” (Snowdon 2005). Even for non-disjunctivists, who would concede that what Macbeth is seeing is a form of distorted perception, the perceptual evidence which the new king is getting from vision is likely to be poor or problematic in several ways. First, the visual properties that he would expect from a dagger, or from a genuine visual experience, are likely to be of poor quality, either because they are degraded, unstable, or ambiguous. What is more, the properties that the dagger appears to have might remain highly surprising given Macbeth’s prior knowledge about daggers, and how they look: For instance, with the prior that daggers do not appear suddenly, or float in the air. If Macbeth turns to touch to get further, and better, sensory evidence, it is difficult to say whether this is because of a privilege of tactile evidence, or because of the paucity of the visual one.

It would be impossible to compare vision and touch in domains where one or the other provided special access, as it is the case for example for colour for vision or temperature for touch. Additionally, some common sensibles such as texture, or types of material might also not be the best candidates, as touch here seems to be better than vision in giving us fine-grain information: we are for instance unable to reliably distinguish glass from transparent polymethyl methacrylate (PMMA) plastic by vision, but can do so by touch (Gueorguiev et al. 2016). Although the surfaces are both absolutely flat and do not differ beyond a few tens of nanometres, the difference in their molecular structure is sufficient to produce differences in the coefficient of friction during tactile exploration, making us above chance to distinguish the two surfaces. Similarly, from the developmental literature, one finds examples of tactile fact checking where young children were observed to use touch to identify the "real" (material) properties of objects(Flavell, Flavell, and Green 1983; Flavell, Green, and Flavell 1986).

We can, however, turn to other cases where touch still appears to have a special comparative advantage, even though vision is not degraded and provides good perceptual evidence. To make this comparison fair, it is necessary to select a domain where the two modalities are equally or comparably suited to the discrimination of the relevant perceptual property - which is the case with the perception

of the spatial properties of middle-sized objects. Independently of the thorny question, raised by Molyneux (Locke, 1688, 1694), of the relation or identity between seen and touched shapes, there is little doubt that the two modalities provide us with information about the shape and size of material objects, with a possibly equal level of accuracy. Spatial properties, like shape or length, offer a fairer comparison between touch and vision, as the two modalities allow for comparable levels of discriminative performance if the object in question can be easily explored by touch. For example, if presented with two matches, in good illumination conditions, one of 2 cm, and the other of 2.5 cm, most of us will be able to visually and tactually perceive them as unequal in length. In this he test-case we narrow the question: Although both touch and vision are equally reliable in providing perceptual evidence about length, does touch offer more trustworthy evidence of length than vision?

There is good evidence to suggest that touch is granted such a superiority over vision (part 2), even in cases which are not analysable as being different in terms of accuracy. Previous accounts tend to situate the privilege of touch at the level of perception itself, interpreting touch as being more 'objective' or offering more direct contact with reality (part 3). The novel account proposed here suggests that touch offers not a perceptual, but a metacognitive advantage: touch is not more objective than vision but provides a comparatively higher subjective certainty (part 4).

## 2. Establishing the comparative privilege granted to touch

### 2.1. Tactile fact checking: A widespread, and confusing phenomenon

Everyday experience shows that touch is the 'fact-checking' sense par excellence (Bremner and Spence 2017). We all like to feel for our keys or wallets in our bags, even if we just saw that we put them there. Despite numerous signs asking visitors not to touch the artworks on display, guards need to regularly stop people from reaching out and touching fragile statues and canvasses. The privilege of touch is also well-known to salesmen: If a client hesitates to buy a product, handing it over for her to touch is likely to seal the deal. A study conducted by Peck & Childers (2006) for instance shows that people are more likely to buy a product that they are encouraged to touch (Peck and Childers 2006). Müller (2013) showed that the boosting effect of touch is largely independent from its informativeness about the product's quality: touching the package of an object, or even a picture of an object is sufficient to significantly increase purchasing behaviour (Müller 2013).

These everyday cases show how difficult it is to apply the distinction we draw between unique access, and distinctive and equal reliability. In most of the cases detailed above, touch provides unique perceptual information that vision does not (for instance, about the weight of the product that one is interested in); it also often provides distinctively better information about certain common sensibles it shares with vision (for instance, the texture of clothes); finally, it probably also provides equally good evidence about some spatial properties like size. This combination makes it difficult to say where the privilege granted to touch comes from and assess its rationality. If we turn to touch for its unique access to the weight of the object or better evidence about the texture of an item of clothing, it would hardly be surprising that we would trust touch more than vision. It is only in the cases where vision already provides sufficient information for the perceiver's belief or decision, and yet still prompts people to fact-check by touch rather than just relying on vision, that the privilege cannot be immediately explained.

### 2.2. Comparative tactile fact-checking

The surprising fact is not that touch is relied upon when it provides information about a unique physical property, or better information than vision: The surprising fact is that touch is called upon when it provides information which is neither better nor different from vision. A famous, albeit literary example here, is the biblical story of doubting Thomas: Thomas had to touch Christ's wounds to be convinced the person in front of him was Jesus. The story here tells us something important. Touching 'to be sure' is especially relevant when our other senses or beliefs create a situation of high uncertainty, in this case, because the information conveyed by the other senses (vision) generates doubt and conflicts with prior knowledge. Individuals with obsessive compulsive disorder keep touching the objects of their anxiety, even though they can look at them: They return to turn off the tap, even when they can see or hear that no water is dripping (Samuels et al. 2017 for overview). Both cases are however difficult to interpret: one, after all, comes from a narrative, while the other is a general clinical observation which covers many different cases, and circumstances. They are certainly not evidence, but invitations to consider the plausibility of a comparative privilege granted to touch, when vision does equally well.

We need here to distinguish between two properties that might be equally well accessed by the sense of touch and vision: One is the existence of the object; the other, are its spatial properties, such as its extension, size, or shape.

The first claim, which is also the most discussed in the classical philosophical literature, recognises that touch is comparatively better than vision in checking facts relative to the existence or reality of the perceived object:

*Existential tactile superiority (Existence-TS)*: Touch is more reliable than vision when it comes to providing perceptual evidence about the existence of an object.

The famous example of Dr. Johnson comes easily to mind when it comes to this first claim: When he wanted to demonstrate the absurdity of Berkeley's idea that material objects did not exist, or so the anecdote reports, Johnson ostensively kicked his foot against a large stone, and triumphantly asserted "I refute it thus." What is relevant to our point here is that Johnson felt that pointing at the coloured shape of the stone, which everyone could see, was not sufficient: vision would not demonstrate the existence of the external world as well as touch would. The resistance of solid objects through touch is meant to provide us with the experience that there are things out there, independent of us and our will (see Fulkerson 2014; Massin 2010 for reviews).

A different claim, not directly relevant to Johnson but important to us, is that touch could be comparatively better than vision in checking facts relative, not to the existence or reality of the perceived object, to the spatial properties of the object, such as its size, or shape[1].

*Spatial tactile superiority (Space-TS)*: Touch is more reliable than vision when it comes to providing perceptual evidence about the spatial properties of objects such as size and shape.

Note that the two claims are delicate to disentangle in a single case: The concept of tangibility, which is often used to characterise evidence, often runs together with the idea of material existence and of spatial extension. Bundled together, it could be that touch is the only sense to give us access to tangible property, that is both to the material existence and the spatial properties of material objects - in which case, one could argue that tangible

[1] Note that texture also count as a spatial property of the surface, but at a smaller scale - as noted above, touch often provides better evidence than vision about texture, and it is not counted here.

properties are the proper sensibles of touch. If tangible properties are uniquely accessible to touch, and inaccessible to vision, then we are back to a case where it does not make sense to talk of a comparative privilege granted to touch, but simply that it offers information that is not accessible to the other senses.

The fact that we don't speak about the same thing when we consider tactile access to the existence of the object, and tactile access to the spatial properties of the objects can be defended on both conceptual and empirical grounds. Conceptually, judgements of existence are indeed binary: They have to determine whether something exists or not, and there is no intermediary where something semi-exists. By contrast, judgements about spatial properties accept many values: An object can be square, rectangular, circular, elliptical, pentagonal, etc. Its side can be 1, 2, 3 or more centimetres long, with intermediate values. When looking at tactile superiority then, it makes sense to ask whether touch is better than vision in a binary 'existential' task (does this exist, or not?) or a estimation task with many more values ('how long is this?). Cast in empirical terms, one could distinguish the superiority of touch in respective detection (existence) or discrimination (space) tasks.

From an empirical perspective, there are many cases where our perception of spatial properties by touch can be dissociated from the perception of the existence or materiality of the object: When we explore a virtual tactile object, for instance, we might know and perceive that there is no real material object that we are exploring, and still be able to perceive some spatial properties, like shape . A similar dissociation might be obtained when an object is placed in our hand, without leading to friction and as such certain properties derived through active exploration. In the first case, we have tactile information about the length or shape of the object, but the material existence of the object itself is (assumedly) not part of our perception. In the second case, we have access to the size or length of the object (as well as its location) but not to its other material properties. Another, subtler, case which will be relevant below, comes from tactile spatial illusion literature: In the tactile version of the illusion known as the Vertical-Horizontal, when one explores an inverted T-shape by touch, the vertical bar appears to be longer than the adjoining horizontal bar of equal length fitted at its intersection (see Fig. 1a). The same bar would be perceived equal in size to the other bar, if the two in a different spatial configuration (Fig. 1b). Here the two perceptions, when the bars shape an inverted T, and when the bars are parallel, do not differ in terms of the information provided about the existence of the bars, but only in terms of the information provided about the relative size of the bars.

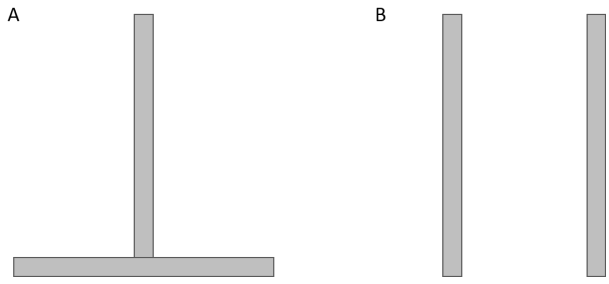


**Figure 1. Vertical-Horizontal illusion.** (A) Bars of equal length arranged in an inverted T-shape lead to overestimations of the relative length of the vertical bar while in (B) arranged in parallel, no difference in length will be observed.

We will only come back at the end to the possible relation between the existential and the spatial superiority granted to touch over

vision, but first we turn to the broader question of how they should be interpreted.

## 3. Touch and objectivity: The traditional response

Existing philosophical accounts have mostly focused on the existential superiority of touch, usually by considering that the special character of touch comes from its direct contact with the material reality, and its resistance to the force we exert onto it. This, certainly, is what Johnson had in mind with his *ad-lapidem* argument. There is nothing wrong with choosing this line, apparently, except that it is not really supporting the superiority of touch: If material resistance is something that touch uniquely accesses, then we cannot talk of a comparative, but only of an exclusive privilege. If vision cannot even compete, touch should indeed reign.

The 'direct contact' views, moreover, do not have much to say about the alternative claim, namely the question of spatial superiority. The extension of the argument here would be that touch as a purely proximal senses provides us with 'direct contact' with the spatial properties of the object, and for that reason, is better than vision which provides has less direct contact with the same properties. The argument is not altogether bad, and it might explain why touch is distinctively better when it comes to texture: the need for direct exploration of the surface in the case of touch means that it can derive subtle spatial information from active touch and friction, and the deformation of the fingertip, which is not the case for vision. Touch, here, has literally more skin in the game as a contact sense, and is distinctively better than vision. However, in the case of size and shape, the argument that touch gives us more direct access to spatial properties is difficult to reconcile with what is known about the sense of touch.

If by direct, it is meant that the process of deriving spatial information is less inferential or mediated than the processing of visual information, the argument certainly fails. Tactile processing is highly mediated, and rests on expectations and unconscious inferences, no less than the other senses. If by direct, it is meant that the experience of touching an object feels more un-mediated than the experience of seeing the same object, the claim may be more plausible, but certainly does not turn into an argument for the object of that experience to be especially objective, once pushed beyond the fact that they are perceived as mind-independent. There is no particular reason to translate the experienced direct contact into the perception being more reliable in estimating spatial properties. Touch is at least as easily deceived as the other senses and as such is equally subject to illusions and hallucinations as vision (see Hayward 2008 for overview). We just don't hear about them that often. To take just one example, many people are surprised to learn that the button on their phones does not really move when pressed: The impression that it does is created by a vibration, which fools the brain into inferring that something was pressed. Switch off the phone and repeat the action, and you will realise that the surface cannot be moved at all (see also Terekhov and Hayward 2015).

When it comes to providing evidence about spatial features like size or shape, rather than the existence, or even texture of material objects, the claim cannot be that touch can provide more objective or more accurate perceptual information than vision, since the relative accuracy of the two modalities depends critically on the context and difficulty of the task. Whether it provides more accurate information than vision, say on an object's shape, or size, depends on the circumstances of sensing. Sometimes touch is better; sometimes vision is. If touch has no general advantage over vision in the perception of spatial properties, such as size, what privilege is left to make sense of a spatial tactile superiority?

## 4. Tactile certainty: A metacognitive account

An alternative way of understanding the anecdotal reliance on touch is then that, for equal accuracy and for the same object or property, people might place more confidence in decisions reached by touch rather than vision. According to the present proposal, the special privilege of touch does not come from perception or perceptual judgements, but from the subjective certainty that this sense modality provides.

A first argument for this proposal comes from experience. An important aspect of touch, often missed when insisting on accuracy alone, is that touching is more psychologically reassuring than seeing. Touch does not always make us experience things better, but it certainly makes us feel better about what we experience. Even when we can see that the keys are in our bag, we are much more certain that they are, once we've touched them. What might seem almost superstitious at first could however have deeper reasons. The assurance that touch gives us makes it rather special in our epistemic life. Descartes came close to this diagnosis when he noted that the evidence we got from touch was somewhat harder to discard: "Of all our senses", he commented "touch is the one considered least deceptive and the most secure" (Descartes 1633). The phenomenological argument is especially adequate to capture the secure feeling of the reality or presence of an object provided by touch. Feeling of presences are documented in the literature in connection with various pathologies were their defect causes individuals to feel that certain objects or individuals are not real. They are also documented in connection with virtual reality, where scenes and objects can be reproduced with high fidelity, but still "lack" reality. What the metacognitive account we are proposing adds here is the idea that feelings of presence (e.g. Lee 2004; Sanchez-Vives and Slater 2005) or reality vary depending on the sensory modality[2]: According the metacognitive account, the feeling of certainty that touch gives that an object is really present is higher, though not more accurate, than the certainty provided by vision. Here, the metacognitive account recommends a revision of the previous claim:

*Existential tactile superiority (Existence-TS): Touch is more reliable than vision when it comes to providing perceptual evidence about the existence of an object.*

in favour of a second one:

*Existential tactile metacognitive superiority (Existence-Metacognitive-TS): Touch is subjectively rated as more certain than vision when it comes to providing perceptual evidence about the reality and existence of its objects, for an equal level of objective accuracy.*

How about the second superiority claim, which relates to space? Is there also evidence of a heightened certainty when we estimate spatial properties by touch rather than vision, such that the spatial tactile superiority, instead of being stated as:

*Spatial tactile superiority (Space-TS): Touch is more reliable than vision when it comes to providing perceptual evidence about the spatial properties of objects.*

is revised as:

*Spatial tactile metacognitive superiority (Space-Metacognitive-TS): Touch is subjectively rated as more reliable than vision when it comes to providing perceptual evidence about the spatial properties of objects, for an equal level of objective accuracy.*

In a recent experiment, Fairhurst et al. (under review) provide evidence for the existence of such a metacognitive advantage given to touch,

[2] For modality-generic accounts, see Dokic and Martin 2015.

when it comes to spatial estimates of size. Observers explored versions of the inverted T's described above as the Vertical-Horizontal illusion. In the illusion, the vertical bar of the T is perceived as longer than its real size and increased by approximately 1/10th. The illusion works both in touch and vision, and in the experiment, these two modalities were used, one to the exclusion of the other: When exploring the stimuli by touch, participants were asked to close their eyes, and only explore the object by touch, through two swipes. When seeing the stimuli, they could simply watch them but could not touch them. The task, in both cases, was to determine whether the vertical bar was shorter or longer than the horizontal bar. The size of the horizontal bar did not vary, but the size of the vertical bar varied, making the comparison with the horizontal bar either clear-cut or on the contrary ambiguous.

What matters in the study however was not the objective accuracy of the perceptual estimates, was expected to be relatively poor given the illusion. What the study looked at was the confidence that participants reported about each of their decisions, both in touch and vision.

This psychophysical study of perceptual confidence arises from a set of new results on metacognitive abilities, showing how the cognitive system assesses and monitors its own states. Numerous studies have shown that the confidence that we put in our perceptual decisions is more or less tracking the accuracy of these decisions: We are more confident in decisions that are more likely to be correct, and less confident in decisions that are less likely to be accurate.

By asking participants to report their confidence both for visual and tactile decisions, the study we conducted could tell us whether, for a similarly ambiguous or clear case, touch would be more trusted than vision. It is worth stopping to consider why this hypothesis is unexpected. Most of the studies of perceptual certainty have looked at vision, but a few others have considered audition, or, less frequently, touch. When they have, they have found that confidence seems to operate in similar ways across senses, which makes sense in a multisensory world. As we will often encounter and explore objects through our various senses, and we need to know which sense (and evidence) to trust. If confidence is to allow the reliability of different percepts to be compared, and appropriate trust to be placed in each accordingly. If confidence tracks accuracy in a consistent manner across modalities, and decisional correctness, then the hypothesis of a tactile metacognitive superiority would not hold (Figure 2, left). By contrast, if the metacognitive hypothesis holds, we would expect that people would be overall more certain of what they touch, rather than what they see, in cases where they are similarly correct (or rather incorrect). If this holds, then we would be right to attribute a generalised over-confidence in favour of touch (Figure 2, middle).

What the results show however is more specific. On the one hand, and contrary to the common currency model, confidence did not operate in similar ways in the two modalities. However, people were not always more confident in their tactile decisions: Overall participants were more confident in vision, which was altogether more accurate, and showed higher perceptual sensitivity. The bias in favour of touch surfaced when cases were highly ambiguous, that is around the maximal point of illusion. While touch was still less accurate than vision in such cases, it was rated as providing more subjective certainty than vision. In what we can call a "Doubting Thomas effect", it is shown that observers are more confidence when exploring the spatial properties of an object by touch rather than vision, not in a general, but in a selective way (Figure 2, right)

For lack of many other studies comparing metacognition in touch and vision (though see Faivre et al. 2017), or addressing the crossmodal and multisensory interactions between touch and vision (see Deroy, Spence, and Noppeney 2016 for discussion), it is difficult to determine whether the metacognitive tactile superiority exists also extends in other cases. If it does, it also remains to be determined whether this superiority will be this time general, showing that touch is always more trusted than vision in the task, or selective, showing that touch is trusted more than vision only when difficulty or ambiguity are high. What this first comparative study does, at least, is provide an interesting nuance to the spatial tactile metacognitive superiority claim, such that:

*Selective Spatial tactile metacognitive superiority (Selective-Space-Metacognitive-TS): Touch is subjectively rated as more reliable than vision when it comes to providing perceptual evidence about the spatial properties of objects, when both modalities are faced with ambiguous evidence, and despite what an appropriate tracking of objective accuracy would prescribe.*

In other and simpler words, we have evidence that touch is more trusted, even when it is not more accurate, when estimating the spatial properties of objects in challenging situations. We also have grounds to think that the metacognitive account bears some truth.

## 5. Why do we comparatively trust touch more?

A bias in our reliance to tactile evidence may therefore be described as either task dependent or dependent of on a level of uncertainty. How are these cases perceptually related (if at all)? Touch may be providing something the other senses don't either because it is simply better suited to deriving information about additional physical properties. If this is the case, this additional information may resolve conflict or ambiguity. What is it that touch is adding to overcome conflict or uncertainty? Additionally, does the potential for deriving this additional information become relied upon or influence and explain our more general reliance on touch?

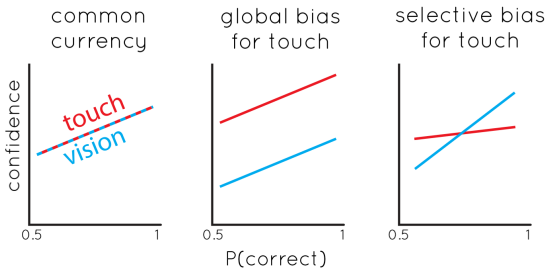


**Figure 2. Confidence across modalities**. For the same level of discriminative performance (Probability (P) correct), touch (red) and vision (blue) may be equally trusted (left). Alternatively, one might observe a either a global (middle) or selective (right) overconfidence in touch relative to vision.

Why would touch bring us more certainty? Two questions can emerge here, depending on whether we think that the tactile metacognitive superiority is selective, and occurs especially in challenging cases, or general (Figure 2). The two require more examination, and careful investigation.

However, the presence of any of these confidence biases is challenging for the way we normatively think about confidence: Our ratings of certainty should track correctness, so that cases where we trust touch more than vision should be the ones where touching provides more accurate information than looking (see Fleming and Daw 2017; Morrison 2017 for overviews, see Navajas, Bahrami, and Latham 2016; Navajas et al. 2017 for discussion of these normative assumptions). But this is not what explains the results of the experiment by Fairhurst and colleagues presented above. Nor do they explain, more

broadly, the attitude of Thomas, or obsessive compulsive disorder patients.

The reasons why touch brings us reassurance and certainty might run deep into what more broadly constitutes our subjective feelings of confidence. Perhaps we trust touch more because we feel more active and in charge when we explore something by touch than through vision(Gibson 1962). This is a subjective impression, as we also actively move our eyes when we see, but the fact that we move our hands across surfaces might explain why we are also more confident in what we touch: We believe that we have actively collected and sampled the evidence, rather than passively received it. Feeling we have 'done this ourselves', we are more certain that it is reliable.

Beyond subjective feelings of trust being the more secure sense, an action-based account finds some grounding in empirical work (Fleming and Daw 2017; Pouget, Drugowitsch, and Kepecs 2016). Confidence in perceptual tasks has been shown to be disrupted when movement speed is manipulated (Palser, Fotopoulou, and Kilner 2018) as well as by transcranial magnetic stimulation of the motor system (Fleming et al. 2015). Additionally, in as yet unplublished data, Gajdos and colleagues recorded preparatory motor activity using EMG to show how the motor components impacts confidence ratings, over and above performance (Massoni, Gajdos, and Vergnaud 2014). This action-based proposal and evidence supporting it would explain a general metacognitive bias toward touch. It would however not explain the selective nature of the bias observed by Fairhurst and colleagues.: there, participants actively explored through touch all stimuli but tactile evidence was only trusted more to resolve high levels of conflict in the highly ambiguous cases.

An alternative or additional explanation in terms of affective reassurance can take better care of both kinds of biases. We may think we are reaching for better information when we touch the visible objects around us, but perhaps we are simply betraying a basic need for reassurance. Here the evaluative dimension attached to touch, which co-occurs with the discriminative capacities of touch (McGlone, Wessberg, and Olausson 2014). could be responsible for this bias, and eventually show more in cases where doubt surfaces.

A further developmental account may rest in the primacy of touch in human development. With the maturation of cutaneous somatosensory receptors at 4-7 weeks gestation (Humphrey 1964), the tactile system shows precedence over vision and hearing (Bremner and Spence 2017). Moreover, and more specific to the case of object and indeed spatial perception, hand to mouth object transport precedes, if only marginally, that of visually guided reaching (Piaget 1953) and thus has been described as the first goal-directed action (Rochat and Senders 1991). Interestingly, this fundamental skill, observed so early in human development in this simple case of oral haptic touch, has been said to show the elementary features of intentionality (Butterworth and Hopkins 1988). Additionally, as a contemporary update on classical theories that touch informs the other senses (Teske 1977), with touch established early on, Bremner and Spence suggest that touch may then serve as "the sensory scaffold upon which multisensory perceptual development is constructed" (Bremner and Spence 2017).

Finally, it could be that the metacognitive superiority is simply due to the heightened certainty, or special access that we derive from touch about the existence of the external object. Those indirect cases would show that confidence placed in a spatial discrimination task could be influenced by the estimates or the confidence relative to another task (detection, or certainty of existence). We know from several studies (Bahrami et al. 2010; Fleming et al. 2010) how metacognition operates in a

detection task, but still ignore what would happen in the case of touch. Whether detection is a good proxy for the judgement of reality talked about by modern philosophers, is also another question for discussion. However, the hypothesis that confidence could be influenced by other signals finds supportive evidence in the literature (Allen et al. 2016) and has been linked to the modulation of the influence of noise on confidence. The idea of a confidence "halo", where confidence in one task is influenced by the confidence put in another, automatic task, remains open.

## 7. Conclusions: Confidence in spatial perception, and questions for awareness.

The present account shows how important it can be to reflect not just on the perception of space, but on the subjective certainty we place in our perception of spatial properties. Touch might well make us more certain of the size of the match we touch, than vision would, even though it is not better. In this paper, we framed the hypothesis as a metacognitive tactile superiority, and discussed its generality, selectivity and possible indirect origins.

Importantly, metacognitive ratings of confidence may also be translated into ratings of various feelings, as well as vividness, and considered as a good measure of awareness. This subjective feeling can be interpreted as linked to feelings of agency, or as a noetic feeling of certainty (conceptually, if not de facto distinct from the noetic feeling of reality (Dokic and Martin 2015) also eventually heightened in touch. It can also be interpreted at the level of perceptual content, for instance as what phenomenology would make us capture as a 'clearer' percept (Morrison 2017). Although these conscious manifestations are important to disentangle and document, the metacognitive superiority of touch, however does not require that they occur, or ground differences in confidence. As such, the present account welcomes the claim, but does imply that there is a *phenomenal* difference in our perception of the existence of objects or their spatial properties when we explore them by touch rather than vision. What the metacognitive account requires is only that we manage to have access to a difference in confidence, and that this drives our decisions and actions, making us, like Doubting Thomas, reach for things we can see.

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