How are the spatial characteristics of the body represented? A reply to Pitron & de Vignemont

Stephen Gadsby
Monash University, Melbourne VIC, Australia
Gadsby.st@gmail.com
Abstract

In their article, Pitron & de Vignemont (2017) provide an insightful and well overdue discussion of the relationship between long-term body representation models and Alice in Wonderland syndrome. Here, I supplement their discussion with a number of observations. First, I present a cautionary note regarding the interpretation of experiential changes in body size as reflective of changes in the content of body representations. Second, I show how their evidence contradicts an alternative model of body representation arising from research into anorexia nervosa—the “LTB” hypothesis. Finally, I highlight a significant issue with their proposed co-construction model.

Keywords

Alice in Wonderland syndrome; Anorexia nervosa; Body representation; Long-term; Body image; Body schema
1. Intro

One of the ways in which we can understand cognitive processes is by studying the ways in which they break down. Specifically, we can study mental disorders which involve impairment of the relevant mechanisms. This general methodology has had significant influence and success in the understanding of how we cognitively represent our own bodies. Somatoparaphrenia, deafferentation, anosognosia for hemiplegia, phantom limbs: the list of conditions which have been used to draw conclusions about how we represent our bodies is expansive. In their recent paper, Pitron & de Vignemont (2017) carry on this tradition, albeit through the discussion of an unduly overlooked condition: Alice in Wonderland syndrome (AIW).

In light of a number of reports from patients suffering from AIW, they discuss three possible body representation models. In this essay, I introduce these within the context of the distinction between short-term and long-term body representation content. I discuss their patient reports and offer a cautionary note regarding the inference from changes in experience of body size, to changes in long-term body image content. I then discuss evidence from research into anorexia nervosa (AN) which undermines the “independence” model, as Pitron & de Vignemont present it. In its place, the “LTB” variation of the independence model has been suggested, whereby both the body image and schema rely on a shared representation of spatial characteristics. I go on to discuss how the proposed evidence from AIW undermines this LTB model. Finally, I assess their own preferred “co-construction” model, highlighting a significant issue.

2. Three potential models

Within body representation literature, a distinction exists between two kinds of information: short-term and long-term. Short-term information is delivered by afferent receptors: joint position, tendon tension and the like. In contrast, long-term information refers to the spatial characteristics of the body (i.e. size and shape), which aren’t directly and consistently available via afferent signals (de Vignemont, 2014). In their paper, Pitron & de Vignemont (2017) focus on this latter category of content, specifically addressing how such content is stored.

Before continuing, I offer some clarifying remarks regarding the short-term/long-term distinction.¹ These terms refer to the usual mode of such content. Given that joint position and tendon tension change often (as we move our bodies) and the brain is directly coupled to these changes, any instance of short-term content will generally have a short existence, as it is soon replaced by new incoming input. On the other hand, the spatial characteristics of our bodies change slowly (along with the growth of our bodies) and there is no direct sensory coupling with such change, so such content generally preserves for longer periods of time. However, this needn’t necessarily be

¹ Thanks to a reviewer for pushing me on this.
so: short-term information related to joint position could maintain over a long-period of time, if no new sensory input were to replace it (such as when we are completely still for long periods). Similarly, long-term information could shift quite rapidly if we were to perceive a sudden change taking place (such as an arm being cut off). Given this, better terms to employ might be “online” and “offline” (Carruthers, 2008), though these have been used in more specific ways elsewhere (Carruthers, 2013).² Despite this terminological ambiguity, I will follow in Pitron & de Vignemont’s use of the terms “short-term” and “long-term”.

Pitron & de Vignemont propose the following three potential models of how long-term content is tracked and stored (see also: figure 1):

a. The Fusion model: There is a unique representation of the enduring properties of the body that both spatially frames bodily experiences and guide bodily movements (O’Shaughnessy, 1980; Brewer, 1995; Bermúdez, 2005; Alsmith, 2009);

b. The Independence model: There are two distinct functionally defined representations of the enduring properties of the body, a long-term body schema for action and a long-term body image for perception, and they work independently of each other;

c. The Co-construction model: There are two distinct functionally defined representations of the enduring properties of the body, a long-term body schema for action and a long-term body image for perception, and they can interact and reshape each other. (p. 116)

² There are also a number of unanswered questions regarding how these forms of content interact. For example, whether they must be stored separately or are sometimes integrated into coherent representational vehicles.
3. Alice in Wonderland syndrome

In an attempt to distinguish between the proposed models, Pitron & de Vignemont offer a fascinating and much needed analysis of a number of AIW case studies. Consider the first two:

Case report n°1: “Often preceding and during the migraine attack I have a very peculiar feeling of being very close to the ground as I walk along. It is as though I were short and wide, as the reflection in one of those broadening mirrors one sees in carnivals, etc. Of course I know it isn’t true.” (Lippman, 1952, p. 349)

Case report n°2: “A patient, for instance, reported: “A feeling that I was very tall. When walking down the street I would think I would be able to look down on the tops of others’ heads, and it was very frightening and annoying not to see as I was feeling. The sensation was so real that when I would see myself in a window or full-length mirror, it was quite a shock to realize that I was still my normal height of under five feet.” (ibid.)

Pitron & de Vignemont claim these as evidence of a dissociation between body image and schema: each patient appears to have a spatially distorted body image (causing their abnormal perceptual experience) despite maintaining an intact body schema (their movements are still guided accurately). Indeed, such experiences seem to be indicative of the standard AIW experience, as it is paradigmatically characterised as a disruption of the body image (Lippman, 1952; Todd, 1955). Before evaluating this
claim of dissociation, I offer a brief cautionary note regarding the interpretation of reports of body size experience as indicative of long-term body image content.

Rather than the more loosely prescribed phenomenological body image notion—defined as any perceptual experience of one’s own body (Gallagher, 2005, p. 25)—Pitron & de Vignemont’s specified target is more fine-grained: a contentful internal state, storing information regarding the spatial characteristics of the body (p. 116; see also: de Vignemont, 2010). Because these notions are distinct, it’s entirely possible that they can dissociate. That is, evidence that an individual undergoes a change in their experience of body size is not necessarily indicative of a change in the content of the long-term body image.

For example, consider the feeling of being very small one often gets when gazing up at tall buildings. Such a feeling is described as an experiential change in body size—looking up at the buildings, we feel that our bodies are small. This strikes me as quite an accurate description of the phenomenology of looking at tall buildings, yet it is unwarranted to assume that each time one glances up at tall buildings, their long-term body image changes in size.3

Similarly, one might undergo a drug induced hallucination, whereby one’s environment appears spatially distorted—perhaps things appear to be growing larger, then smaller, as if they were breathing. Such an effect might also hold when one looks at their own hands. Again, however, it would be hasty to assume that this was evidence of a cognitive change whereby long-term body image content (representing the hands) was fluctuating.4

This isn’t to state that such experiences emphatically don’t involve changes in stored size content—only that they need not necessarily, and we ought not immediately assume that they do. While worth highlighting, I will nevertheless put these issues of interpretation aside for now. In order to offer some fruitful insights of my own regarding possible body representation models, I herein simply follow Pitron & de Vignemont in their interpretation of the discussed case studies.

4. The independence model

Pitron & de Vignemont claim the aforementioned case studies suggest a dissociation between body image and schema—a claim which is, by now, fairly well accepted in the literature. From this, they argue that the fusion model is untenable: it cannot accommodate evidence of such a dissociation. So far so good—whilst some

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3 One might object that this is simply a turn of phrase, not supposed to be in any way indicative of phenomenal content. Even if this is the case, it still places doubt on patients’ descriptions of abnormal body size: it might be that they are simply describing the sort of feeling one gets when one looks at tall buildings, rather than the sort of feeling one would get were they to suddenly change in body size.

4 Perhaps the visual hallucination might cause long-term body image content to fluctuate, though this would be distinct from the claim that long-term body image content was driving the hallucination (what seems to be the suggestion for AIW).
philosophers have made reference to a single representation of spatial characteristics subserving multiple cognitive domains, those who actively work within the field of body representations have long ago abandoned anything resembling the fusion model.

Moving on, they turn to evaluating what can rightly be considered the standard assumption within modern body representation research: the independence model (de Vignemont, 2010). In this, the body image and schema operate on distinct functional pathways, corresponding only via shared sensory input. Pitron & de Vignemont don’t cast much doubt on this independence model, as it clearly handles the apparent dissociation evidence from AIW case studies. Further, the model accounts for the usual congruence between the two representations: after all, both types of representation are fed by the same inputs—from the body itself—so congruence should be expected (p. 119).

5. Anorexia Nervosa and the LTB model

While Pitron & de Vignemont give us no significant reason to doubt the independence model, there is one strand of clinical evidence which contradicts it. This is drawn from research into anorexia nervosa (AN), a disorder with a long-standing association with body image distortion (Slade & Russell, 1973). While AN patients profess to feeling larger than they truly are, more robust evidence of long-term body image distortion is offered by experiments involving body size estimate tasks. Such tasks ask participants to estimate the size of their bodies, with overestimation taken as evidence of an oversized body image (Smeets et al., 1997).

In recent years, it has further come to light that AN patients exhibit distorted body schemas: they move and assess their ability to move as if their bodies were larger than reality (Engel & Keizer, 2017; Gadsby, 2017a; Guardia et al., 2010; 2012; Metral et al., 2014; Keizer et al., 2013). Furthermore, there is evidence of a direct match in the content of these distorted representations. In one study, Keizer and colleagues included a task which measured the shoulder width content of both the body image and schema, discovering a match in content between both representations, despite both being distorted (Keizer et al. 2013, p. 4). Given that the sensory signals themselves appear to be intact (Gadsby, 2017b, p. 27), the pertinent question here is not one of dissociation (as in the case of AIW), but correspondence: where does the distorted content arise and how is it shared between each representation?

This evidence spells trouble for the independence model. If the body image and body schema only share content via sensory input, then how can content correspondence arise if not through sensory input? The answer proposed maintains the basics of the independence model but suggests that the body image and schema both rely on the

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5 They do briefly suggest that the independence model undermines the extent to which the representations can even be thought of as independent, given that it posits that their processing is similar (p. 119). I don’t put much weight in this challenge: the standard assumption in the literature is one of independence and there is a wealth of evidence to support it, much of which pertains to differences in the processing involved (de Vignemont, 2010).
same prior regarding spatial characteristics of the body (Gadsby, 2017b). This prior (referred to as the LTB, an abbreviation of long-term body representation), tracks and stores the spatial characteristics of the body. This stored content is used to generate the body image and schema dynamically, according to task demands. While this process of generation can result in content differences, correspondence can be explained by assuming that the content derives from the shared prior.

6. Case study #5

Although Pitron & de Vignemont don’t draw this point out, there is one aspect of the AIW research they discuss that appears to contradict both the independence model and its LTB variant. Beyond the two aforementioned cases, there appears to be an instance of AIW whereby both the spatial content of the body image and schema are distorted:

Case report n°5: “In 1940, during the period of headaches, he felt his fingers lengthening, and even looking at them he found them very long; when he wanted to touch his head with his fingers he couldn’t calculate his movement and his fingers always went higher than his head …” (Hécaen and Ajuriaguerra, 1952, p. 262; from Pitron & de Vignemont, 118)

If we follow Pitron & de Vignemont’s interpretation of this case as evidence that both the patient’s body image and schema are distorted, it seems analogous to AN. That is, the patient exhibits distorted content correspondence, despite this content (presumably) not originating from the incoming sensory signals themselves.\(^6\) We might then suppose that this is even further evidence against the standard independence model and towards the LTB variation, whereby both the body image and schema share a prior.

Yet considered in light of all the mentioned case studies, AIW in fact appears to undermine both the independence and LTB models. To render this argument clear, I will first lay bare its background assumptions. The first assumption is that the AIW patients discussed—those with only body image distortion (BI) and distortion of both representations (BI&BS)—are genuinely afflicted by the same condition, AIW, and that this condition is what causes the distortion. Further, it must be assumed that this condition is (more or less) homogenous at the cognitive level; that is, each of the AIW patients share the relevant cognitive dysfunction.\(^7\)

So the question at hand is what kind of cognitive dysfunction could result in the evidence discussed. The BI&BS case acts as a counter example against any hypothesis

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\(^6\) Pitron & de Vignemont don’t specifically discuss this as a possibility; I take this as evidence that they assume the issue is not the incoming signals themselves and will simply follow them in this assumption.

\(^7\) For some, this assumption may seem too obvious to mention. Yet given current debates regarding the causal diversity within psychopathological categories, I believe it’s worth explicitly acknowledging (Clutton, Gadsby & Klein, 2017; Tabb, 2015).
which claims the dysfunction causes just one of these representations to become distorted—the only possibility available under the standard independence model. Similarly, we can’t explain the BI case within the LTB framework by claiming that the distortion originates in a shared prior (as was suggested for AN). If such a hypothesis were true, then all instances of AIW should exhibit distortion in both representations, as the body image and schema are dynamically generated based off the shared (distorted) content. As long as the stated assumptions hold, the evidence from AIW seems to contradict both the independence and LTB models.

7. The co-construction model

Pitron & de Vignemont’s co-construction model isn’t proposed to make up for the deficiencies of the independence model. Rather, a driving motivation seems to be principles from broader, more well-known approaches to modelling cognition: Marr’s three step model of visual perception and Bayesian modelling.

First, they introduce Marr’s (1982) three-step model. Integral to this model of vision is the notion of sketches. As signals progress from earlier to latter visual systems, representational stages can be identified: 2D retinal images give rise to intermediate 2.5D sketches before becoming fully formed 3D representations. Next, they inform their model with principles borrowed from Bayesian modelling—an increasingly popular approach towards understanding cognitive function (p. 119-120). What they arrive at is a model where the first step is the generation of two distinct “body sketches”: “raw body schema and raw body image” (p. 120). After these raw intermediate sketches are generated, the representations are “compared and averaged”, a process whereby the content of each representation influences one another:

The averaging process obeys its own Bayesian rules and given the context it can give more or less weight to the body image, which therefore has more or less impact on the body schema, or vice versa. (ibid.)

They thus propose a model whereby, despite having distinct priors, each representation influences one another’s content in a more or less direct manner (see figure 1).

7.1 Assessing the model

Let’s take a look at how well this co-construction model accounts for the evidence from both AN and AIW. Such a model does indeed explain why there might be instances of dysfunction which cause distorted content to correspond between body image and schema (i.e. AN and AIW-BI&BS). The transfer of this content would occur in the intermediate stage where the functional pathways interact. So, for example, either AN or AIW-BI&BS might arise from a dysfunction which causes distortion of the raw body image. Such distortion would then spread to the body schema during the intermediate stage, accounting for the correspondence between the two representations.
But what of the usual AIW cases, whereby only the body image is affected? To account for these, Pitron & de Vignemont make the following suggestion:

Most of the time, the two body representations use each other to maximize their chance of being correct and their contents get coherent. But under some rare circumstances, namely in some cases of body illusions and hallucinations, the averaging system fails and the two body representations diverge (p. 112)

They suggest two kinds of dysfunctions which could cause this usual averaging process to break down: abnormal “confidence weightings” and a “failure at the level of the comparison between the two raw contents” (ibid.).

This is where their explanation turns problematic. Pitron & de Vignemont claim that the usual operation of the system is to arrive at “coherent” content between both representations and divergence only occurs as a result of dysfunction. By this, I take them to mean that the outcome of the averaging process is one whereby the content of both representations corresponds i.e. an increase in similarity occurs.8

Yet we ought to question whether the usual averaging process should produce corresponding content. Consider evidence of the body schema’s ability to incorporate the spatial content of tools (Cardinali et al., 2009; de Vignemont & Farne, 2010). This function suggests that the content of the long-term body schema is not simply of our own body but of any action relevant effectors: body parts, tools and even—to reuse an extensively cited, yet somewhat outdated example—the feather of a lady’s hat (Head & Holmes, 1911)! On the contrary, representation of tools is not a function of the long-term body image.

That the long-term body schema reflects the spatial content of any action relevant effectors, while the long-term body image only represents the body, contradicts the claim that the standard order of business is for their contents to correspond, rather than diverge. At very least, it suggests that this intermediate stage must be significantly more complex than Pitron & de Vignemont propose. Rather than simply comparing and averaging, such a process must recognise spatial content purely related to tools and ensure this content doesn’t seep into the body image.

Putting this aside, an even more problematic aspect of Pitron & de Vignemont’s model is that it seems to contradict their own evidence from AIW. If it were the case that the usual mode of operation was one where content between the two representations corresponds, then we should see an opposite pattern from the one shown in case studies. That is, most patients should exhibit distortion in both representations. It should only be the rare few who happen to exhibit additional dysfunction, whereby the sharing of content breaks down and distortion is only seen in the body image. This is not the case: Pitron & de Vignemont’s analysis seems to

8 Though Pitron & de Vignemont point out that the process doesn’t result in a perfect match, the suggestion does seem to be that close correspondence is the goal.
sugge\[\textit{t}\] suggest that shared distortion is a rarity—as they refer to it, an “oddball” (p. 118). For these reasons, the co-construction model needs significantly more work.

8. Conclusion

Any model of body representation must be able to account for the myriad of ways in which these processes breakdown. The first step in meeting this challenge is to analyse and categorise the various psychopathologies which involve body representation dysfunction. In this respect, Pitron & de Vignemont’s article is an unarguably valuable contribution to the literature.

The next step is to compare the models with the implications of the relevant evidence. I have restricted myself here to only discussing AIW and AN, though comparison with other psychopathologies is also necessary. In order to account for these two disorders, a model of long-term body representations must posit some way in which the representations can share content, independent of shared sensory input. This could occur either through a shared prior (as in the LTB model) or some more direct form of influence (as in the co-construction model). Nevertheless, I have suggested that, in the way they have been proposed, both the LTB and co-construction models fail to adequately account for the evidence from AIW. As such, there is still much work to be done.

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