What is the brain doing in the sensorimotor theory?

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Abstract. The sensorimotor theory considers experience to be a thing we do, claiming that experiencing, say, redness, consists in currently exercising mastery of a sensorimotor engagement with something red. Under this view, the quality of a particular experience is constituted by those laws that govern the interaction underlying that experience. We emphasize that this de-reification of experience appeals to *potential* action and its sensory consequences, pointing out that exercising mastery of sensorimotor contingencies does not require present action. What is the brain doing when we are exercising this mastery? How does the brain relate to the multiplicity of possibilities linking possible actions to resulting sensory changes? We reject the view that these sensorimotor contingencies are explicitly represented in the brain: all that is necessary is that there exist mechanisms in the brain able to test their presence. We suggest that as observers become acquainted with sensorimotor contingencies, fewer neural resources are necessary to group together the multiple counterfactual sensorimotor contingencies associated with a given experience.

1 BRIEF INTRODUCTION TO THE SENSORIMOTOR THEORY

The idea that experience must necessarily be generated by the brain has led to decades of research on neural correlates of consciousness, with a variety of hypotheses (ranging from recurrent cortico-thalamic oscillations to quantum gravity effects in microtubules!) failing to make progress in explaining the phenomenal quality of experience.

As a remedy, the sensorimotor theory starts anew on the issue of experience, proposing that there is a category mistake involved in thinking that experience is the kind of thing that can be generated by anything, let alone by brains. Instead the sensorimotor theory suggests that we should consider experience to be a thing we do, like a skill [1]. For example, a bodily skill like skiing is not "generated" in the brain, but rather, it consists of a certain ongoing interaction with the environment. The sensorimotor theory extends this idea to sensory experiences, claiming that the experience of say red, is constituted by our bodily, sensory engagement with red things.

Under this view, the quality of a particular experience is constituted by those particular laws that govern the interaction underlying that experience. So for example the quality of softness of a sponge is constituted by the fact that when you press it, it squishes.

The wager of the sensorimotor theory is that de-reifying experience in this way is a tactic which will be as successful as was the de-reification of the notion of "life" at the beginning of the 20th Century, a tactic which led to abandoning the idea of vital spirit and to the birth of modern biology.

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2 NOT ACTION, BUT POTENTIAL ACTION

A key notion in the sensorimotor theory is action. As is the case in the execution of any skill, the theory claims that there can be no experience without the perceiver's activity. However it is important to understand that the perceiver need not act now. Just as the jeweller is immobile as he solders the ring, just as the dancer pauses an instant in his dance, having an experience implies being in the process of masterful sensorimotor engagement. But "having mastery of sensorimotor contingencies" does not require action at this very moment. Rather, it involves having implicit knowledge or mastery of a variety of currently possible actions and their consequent effects on sensory input. Experiencing involves being "tuned" to the possible changes in sensory input, in the sense that one is in a state where one knows implicitly that if one makes this action, this change in sensory input will occur, and if one makes that action, that change will occur.

The fact of appealing to potential action and (counterfactual) sensorimotor contingencies allows the theory to account for perception without action, but also for dreaming, imagining, hallucinations and even synaesthesia. By further appealing to the notions of "bodiliness", "insubordinateness" and "grabbiness", the theory can also account not only for the sensory quality, but also for the degree of experienced perceptual presence of such experiences (e.g. [2]; [3]).

3THE MEANING OF MASTERY

What is the brain doing when we are exercising mastery of sensorimotor contingencies? How does the brain relate to the multiplicity of possibilities according to which if we do this, then that will happen? Does it have a large list of all the possible things we can do, and all the possible expected sensory consequences?

This would be at best un-parsimonious and at worst impossible, given that there are probably an infinity of possibilities. An alternative is to assume that the brain has a shortcut way of determining whether a particular law (or invariant) is applicable, allowing the current sensorimotor contingencies to be grouped together in this or that experience.

To illustrate, take the case of colour. A sensorimotor approach to the experience of colour has been proposed recently by [4], and provides an appealing account of classical phenomena about colour naming and unique hues. According to this, experiencing colour consists in currently engaging with the changes in retinal photoreceptor excitations that will occur when you move a coloured surface around under different illuminations. Thus for example, the light reflected off a red surface will change drastically when you move the surface from a white room to a blue room: and despite this the surface continues to appear red. To identify a surface as red however, the brain need not predict each such change. Instead, it can simply determine if a particular relationship holds between the sensory

stimulation from the illuminant and the sensory stimulation from the surface. The work shows that this relationship can be accurately represented by a 3 x 3 matrix, distinct for each colour.

Thus seeing red does not consist in predicting at every moment what precise changes will occur in sensory input -- but in the fact that the changes that occur are compatible with the matrix corresponding to red. And more generally in all sensory experiences, the sensorimotor theory proposes that the multiple (counterfactual) possibilities inherent in implicit knowledge of sensorimotor contingencies will not each be precisely instantiated in the brain. Rather, a much more economic neural process will exist which allows ongoing sensorimotor contingencies to be grouped together within particular percepts without anticipating the exact sensory states expected for each possible action. Gilbert Ryle expresses a similar idea in describing what happens when one is perceiving a thimble: "Knowing how thimbles look, he is ready to anticipate, though he need not actually anticipate, how it will look, if he approaches it, or moves away from it..." [5]. In other words there is no real anticipation in the sense of recreation of the expected stimulus. There is just confirmation that the law applies.

Perhaps a link may be made here to hierarchical predictive coding theories, where the 'predictions' being made are not of actual sensory inputs, but of higher-level, and thus more economic, neural activity (cf. [6]). Another link to be made with current brain theories is the following. The sensorimotor theory suggests that as observers become acquainted with the sensorimotor contingencies involved in a sensation, fewer neural resources will be necessary to group together the multiple counterfactual sensorimotor contingencies which are associated with that skill. The reason is that by adapting to a sensorimotor invariant you become relatively insensitive to the variations. This is reminiscent of the finding that skill acquisition decreases the activity in various parts of the brain during performance of a task (e.g. [7]).

4 A FINAL NOTE: ARE SENSORIMOTOR CONTIGENCIES REPRESENTED IN THE BRAIN?

Just as the sensorimotor theory rejects the idea that experience is generated in the brain, the sensorimotor theory also rejects idea that perception involves activation of internal representations. Experiencing the world does not involve having pictures or descriptions in our brains -- it involves interacting with the world in a masterful fashion. Experiencing should be de-reified like life has been de-reified. Experiencing is a particular way of interacting with the world.

Yet it could be objected that in order to interact with the world in a masterful fashion, there must be "something going on in the brain" that allows this mastery, and that this something represents the sensorimotor contingencies. For example, the matrix corresponding to red must be stored in the brain in some way, and when this storage is activated, we see red. Surely then, seeing red is "activation" of the representation of matrix A!

BUT NO: seeing red involves activation of the neural processes enabling the interaction that is described by the matrix for red. But the neural processes do not themselves describe the matrix, or contain the phenomenal quality of experience. The experience of red lies in what you do when you are interacting in the appropriate way.

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