"The anticipatory drive leads to … the generation of self representations" (§4)
▪ …the generation of mental constructs of the self
▪ …the generation of implementations of the self
"…the suitability of the inverse structures strongly depends on state and goal representations" (§24)
▪ …strongly depends on the mental operations of states and goals
▪ …strongly depends on implementations of (the operations of) states and goals
"In the motor cortex, body representations are usually posture-encoded" (§40)
▪ …mental operations of the body are usually posture-encoded
▪ …implementations of the body are usually posture-encoded
"For more elaborate object representations, more complex interactions with the object …" (§51)
▪ For more elaborate mental operations of the object …
▪ For more elaborate implementations of the object …
"…brain modules and mechanisms that include various forms of self-representations" (§81)
▪ …mechanisms that include various forms of mental operations of the self
▪ …mechanisms that include various forms of implementations of the self

Table 1: Possible reformulations.

14 To determine which of the two reformulations would be more appropriate in these examples and in the whole 111 instances of "representation" in the target article would require either a deep and complex analysis of this and related texts by Butz or, even better, a collaboration with Butz himself: I would be happy to participate in such a work, if Martin Butz would be interested.

15 Avoiding the term "representation" would make the article much more consistent with a radical constructivist way of thinking. It would also open up unexpected opportunities for realizing the potential of some of its most interesting ideas, such as the connection between anticipatory drive and attention (§31).

Notes

1. The author uses the term "representation" 111 times (5 times in the abstract) and its root "represent-" 140 times, with the forms: represent-ation, represent-ations, to represent, represent-s, represent-ed, represent-ing, represent-able, self-representations, representational (6 in the references). As a comparison, the key term "anticipatory" appears 89 times and its root "anticipat-" (like in "anticipatory", "anticipation", etc.) is used 114 times.

2. Conceptual structures can involve both figurative and operative elements (Glasersfeld 1995: 98): figurative elements are abstracted from sensorimotor experience; operative elements (for example conceptual relations) are constituted of attentional operations.

Treacherous Terms

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1 The author argues that the ability of organisms to anticipate outcomes of actions is crucial for the construction of experiential reality and, ultimately, the generation of consciousness. His paper is a most interesting exposition of the hypothesis that the most evolved organisms have acquired an "anticipation drive" and is a detailed account of this drive's proposed role in the development of the higher functions of the human brain. The author wisely states at the end that "how these mechanisms work together, how they maintain the continuous overall activity balance between the interacting brain areas, and how they ultimately control our individual selves and constitute our selves at the same time will still be under debate and researched for many years to come."

2 I am not sufficiently versed in the neurophysiology of the brain to evaluate the physical plausibility of this hypotheses but there are a number of questions that a student of cognition and language can raise that may be of help in tightening the author's proposal.

3 Those of us who have tried to expound and explain constructivism in the past have been incessantly hampered by the traditional implications inherent in the use of a natural language that was formed and developed in a climate of naïve realism. It is difficult to remain aware of the fact that if someone says, "There is a squirrel," he is actually saying that he *seeing* (i.e., isolating in his visual field) an item that he categorizes as "a squirrel." Although it sounds like it, he is not talking (and cannot talk) about squirrels as though they were independent of his perceptual activity.

4 A somewhat analogous ambivalence is created for Butz by the term "code" in the variety of combinations that the author uses ("perceptual" §23, "anticipatory" §28, §32, "sensorimotor" §37, "neural" §40, "interaction" §52, §54, "behavioral" §66, "language" §76) and other terms such as "encoding" (§§39, 40, 41, and more). Let me stress that I am not bringing this up as a criticism, but as something that, in my view, requires clarification.

5 In ordinary English, "code" means an item or list of items that are *semiotically* linked to something else, something to which they are not otherwise related. The semiotic link is the result of a convention and its intension cannot be inferred from either of the two linked items. Genetics and computer science have borrowed the word "code" and given it a different meaning. An item of the genetic code transfers its "information" by a physical copying process in the generation of other molecules. In our computers, the transfer of "information" is achieved by the interaction of electrical charges. Hence such transfer is a causal affair and in neither case is there the need for a reflecting agent

that is aware of a conventional meaning. This is an important difference from the semiotic domain, where knowledge of the particular convention is the *only* way of "reading" a code.

6 In §44, the author mentions the reliability of information and the incorporation of prior information by means of a Bayesian-like "information integration processing mechanism..." and he concludes:

> "Unlike sensory information sources, motor information activates predictive sensorimotor codes, which predict changes in body perception that are dependent on the executed motor commands."

7 I find it difficult to unravel the paragraph, because I cannot make up my mind whether "information" has to be interpreted semiotically as the instruction to select a specific item from a pre-established code, or biologically as the causal trigger to an action. The first interpretation, it seems to me, would invalidate the hypothesis as a model of the arising of consciousness because it entails an agent who is aware of coded meanings. The second interpretation would, I think, require further explanation that avoids ambivalent terms.

8 Similarly, in §72 the author states: "In turn, these complex interactions," (i.e., between different individuals) "mediated by simple commands, must have started to lead to increasingly advanced symbolizations." – If a command, as for instance in the military, is nothing but the trigger for a particular action, it does not function as a symbol, but its sound-image has, for the receiver, become the physical cause of an action. As such, it may well lead to more complex causal connections; but in order to lead to "more advanced symbolizations," a reflective agent has to be posited, and this, it seems to me, seriously interferes with the intention of explaining the genesis of consciousness in terms of neurophysiological mechanisms.

9 In short, I feel that the use of terms such as "code," "information," and "symbol" for neural constellations that are not further described defeats the intention of the analysis presented because unless these terms are explicitly given specific neurobiological definitions they inevitably suggest the presence of a consciously reflecting agent.

The Mind Is Not In the Brain

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1 This is a fine article, which makes many excellent points, in particular about the importance of anticipation; and how nice it is to see Kant so aptly quoted in a scientific text, what's more in the original German! I do, however, have one serious criticism: it concerns the "internalist" stance adopted by the author. The article opens with the statement "perceived reality is a complex construct"; clearly, no constructivist could disagree with that! However, in the very next sentence Butz simply assumes, without argument, that we are dealing with an "*inner*" construct; he goes on, throughout the article, to speak of "*inner* realities." I would like to explain (a) why I think this is a mistake; and (b) why it is a serious mistake … *especially* for constructivists.

2 Much of the problem stems from the way the article rather glibly talks as though the *brain* were itself a cognitive subject. This is apparent right away in the title, where "the brain" is attributed the status of an agent; later on "… the brain has to develop an additional representation of self…" (§66), and so on. A related problem concerns the way the author talks of "mirror neurons" (§§63–69), again as if neurons could actually do things such as imitate, empathize, and so on. The neurophysiological observations concerning "mirror neurons" are certainly striking, and it is understandable enough that they have caught the popular scientific imagination. But it is vital to understand that "mirror neurons" are merely correlates, phenomena that are *to be explained*; they are *not* themselves a proper explanation of any cognitive behavior and function. Talking about neurons and brains as though they were themselves *bona fide* subjects is a category mistake: it is *people* that perceive, think and so on, not brains. I suppose that for most people nowadays, in the West anyway, it simply seems "obvious" that consciousness, and mental activity generally, are processes that take place "in the brain"; indeed, that psychic activity *just is* – neither more nor less than – brain activity.

Sometimes, however, it can be salutary to question the obvious.

3 Much confusion arises from the fact that the brain is so enormously complicated, and its functioning so mysterious, that it is easy to believe almost anything and indeed to attribute it with quasi-magical powers. Artificial neural networks comprising a mere dozen or so "neurons" can give rise to very intricate behavior in real or simulated robots; and the dynamics involved are already so complex that even in these relatively simple situations, where it is possible to have complete knowledge of the system, it is far from trivial to understand exactly what is going on. What are we to make, then, of the human brain with its 10^9 neurons and 10^{11} synapses? What is done in current neuroscience is to correlate *differences* in mental activity with *differences* in brain activity, giving rise to the colored brain-images that have become so familiar. Precisely because we do not really understand what is happening, the temptation is strong to believe that we are actually *seeing* mental activity going on. However, correlation is not cause; and it is important to resist that temptation. To explain why, I will adopt a ploy proposed by Mikael Karlsson (1996) and compare the relation between brain activity and cognizing with a far simpler case that we *can* understand properly: to wit, the relation between leg activity and walking.

4 Clearly, we could not walk if we did not have legs – just as I fully admit that we could not cognize if we did not have brains. But it does not follow, *at all,* that walking "is" neither more nor less than leg activity. For example, an astronaut floating in weightless conditions could move her legs all she likes – that would not be walking. For leg movements to be involved in actual walking, a whole set of contextual conditions are necessary. The legs must be attached to an upright body, in a gravitational field and on a reasonably flat, more or less horizontal surface; there must be adequate friction between the feet and the ground; and so on.

5 An interesting point arises if we ask *where* the walking is taking place. Actually, it is rather difficult to give a precise spatial location to the walking. *Parts* of the walking have a precise location: I can say that this morning my walking started from my apartment when I left it, and stopped when I got to the café where I sat down to have a drink. But the