helplessness has subsequently been investigated in humans and is implied in some forms of depression (a psychological disorder, characterized by feelings of sadness, anger and frustration). It is assumed that a perceived absence of control over the outcome of a situation contributes to depression. The anticipation of not being in control is contrary to what the anticipatory drive stands for: the ability to control oneself and the environment. Thus, anticipations may not always promote enhanced control of oneself and the environment.

3 Everyone has probably at some point in their lives experienced something akin to "worry" – a lasting preoccupation with future bad events, which may or may not occur. Though worry has some beneficial effects, because it enables someone to prepare for negative events (e.g., one starts to search for a new job when one is worried about losing the current one), this is not always the case. Chronic and exaggerated worry (without a substantial cause justifying the degree of worry) is the key characteristic of generalized anxiety disorder. Persons with generalized anxiety disorder may worry excessively about health, money, family, or work, and continually anticipate disaster. The capacity to anticipate aversive events is therefore, on the one hand, important for successful adaptation, and on the other hand also plays a role in the abnormalities that contribute to excessive worry and anxiety. Thus, anticipation may not always be beneficial.

4 Memories of emotional events are enhanced compared to memories of other types of events. Nitschke et al. (2006) showed that brain activation during the anticipation of seeing aversive pictures predicted memory of those pictures after they had been viewed. Anticipation of aversion recruits brain regions that are associated with memory for emotional events, thereby potentially enhancing the responses to aversive events. The act of anticipation may play an important role in how fresh the memory of a negative event remains. Thus, anticipation of emotional events plays a key role in the enhancement of emotional memory, particularly with negative emotions. This mechanism seems to be an important aspect in social phobia, the fear of being evaluated negatively in social situations (for example when giving a presentation). The expectation that something bad is going to happen may enhance the memory of it if indeed a social interaction does not work out as smoothly as one might have wished for. This leads to a vicious cycle, increasing anxiety before and during the next social situation even further. Again, this example illustrates that anticipation may not always be beneficial.

5 Deficits in processes related to anticipation have been proposed for a variety of other disorders, e.g., schizophrenia (Frith, Blakemore & Wolpert 2000), autism (Williams et al. 2001), and alien hand syndrome (Spence 2002). On the one hand, this and the above examples of maladaptive anticipations strengthen the importance of the concept of an anticipatory drive due to its explanatory power. On the other hand, one should be aware that anticipation per se is not necessarily only adaptive, but that anticipations can be maladaptive.

6 One open question with respect to adaptive and maladaptive functioning is whether the construction of the self is related to the strength of the anticipatory drive or to the content of anticipations. It could be that the strength of the anticipatory drive itself is important – excessive worry may be due to a too strong anticipatory drive. The strength of the anticipatory drive could also be irrelevant; rather, it is the content of anticipations that may shape the development and the construction of the self.

Predicting Events Without Miracle Neurons

Towards a Sober Consideration of Brain Data

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1 Butz's proposal is heir to the challenging tradition of conceiving of the brain (and mind) as an anticipatory device. He outlines anticipatory mechanisms referring, inter alia, to the external environment as containing objects with which we learn to interact, and as containing other selves whose actions we learn to understand. Surprisingly, the paper entirely neglects the issue of the dynamic properties of our environment. Focusing on (static, inanimate) objects only, it fails to acknowledge that anticipation becomes especially relevant when things around us change without being under our control: this is when we are forced to adapt quickly to new circumstances. To estimate as precisely as necessary *what* will *when* be *where* is of vital meaning. Surprisingly though, this issue is not addressed at all. Although it is acknowledged that the environment contains dynamics that are to be predicted somehow (§3) and that have to be represented in the brain somehow (§28), concepts about and empirical data on the prediction of external events are not dealt with further.

2 There is a large body of research that uses imaging methods in humans and patient studies to investigate anticipation of environmental change and its relation to anticipation of change induced by ourselves (for overviews, see Schubotz & Cramon 2003; Schubotz 2004, 2007). It shows that change induced in our environment, no matter whether generated by animate or inanimate entities, calls for our particular *premotor* attention. Using abstract stimulus material, it was found that the prediction of external events, even those that are not reminiscent of actions or agents, relies on our "motor system." The pattern of activations suggest that predictive algorithms differ with regard to their neuroanatomical location within premotor sites, showing that spatial, object-based, rhythmical and pitch-based predictions engage distinguishable dorsal-to-ventral premotor fields. Against the background of these data, I have recently outlined the idea that a predictive account of the motor system can be generalized from action to events (HAPEM framework, Schubotz 2007). Accordingly, prediction of events is achieved with the aid of sensorimotor-driven forward models that are housed by the premotor cortex and that are neuroanatomically ordered according to the styles of transformations they describe. It was suggested that they can be applied to actions as well as to any kind of event that happens in the several seconds range.

3 The HAPEM framework suggests a close relationship between anticipatory attention and our ability to control our movements. This seems in line with Butz's account that

stresses that prediction has not evolved for the sake of prediction but for the sake of anticipatory behavior and action (§3). However, this may be a trivial statement as all of our abilities, including perception, have, in the end, evolved for adapted behavior and adapted actions. More importantly though, pointing teleologically to action a priori biases the appraisal of empirical findings and particularly brain imaging findings in a special way, as recently reflected by the great elation for *embodiment*. It has to be kept in mind that it is not at all clear what kind of algorithms we see at work when the "motor system" is engaged in a task: hundreds of thousands of neurons have their place in a single measured voxel and may serve a mosaic of phenomenologically moderately related behavioral functions. Thus we call the motor system "motor system" simply because motor control is one of its most prominent functions – until we see how motor control and further functions are more appropriately subsumed under a new umbrella term – for instance "prediction system" instead of "motor system."

4 Two casual claims of the paper clearly have to be rejected on the basis of neglected imaging data: firstly, that "unlike sensory information sources, motor information activates predictive sensorimotor codes" (§44); and secondly, that "brain modules that are not directly connected to sensory input or motor output will process inherently anticipatory codes" (§28). Provided that the variable meanings of terms such as "code" or "brain modules" are properly understood here, findings suggest that perception suffices to activate "predictive sensorimotor codes" (namely in premotor-parietal loops), and that the "processing of anticipatory codes" does happen inter alia in brain areas that are indeed directly connected to sensory input and motor output (namely in the motor system) (for details, see Schubotz 2007).

5 Strikingly, although the paper refers in large portions to issues and models of motor control, it neglects a function of mirror neurons in motor control that has been put forward as their genuine one. As pointed out by Keysers and Perrett (2004), the network that embeds mirror neurons plays a role in predicting change produced by the animal itself and in the distinction of this kind of change from change induced by another animal (explaining why, for instance, the animal is not frightened at the appearance of his own forelimb approaching a target in front of it). This, in fact, may be an interesting point at which to start speculating, if one wants to, about mirror neurons' contribution to perceiving our own bodies and becoming aware of our "embodied self." As Keysers's and Perrett's paper stresses, however, it seems reasonable to step back and try to recover a more realistic sense of proportion: the interpretative burden on mirror neurons now seems to overwhelm a thin and sober data basis.

6 However, Butz, like many others these days, alludes to these veritable *miracle* neurons as underlying our ability for empathy (§69). It is noteworthy that no one has yet demonstrated any empirical evidence in favor of this claim. Furthermore, *no one has found any direct evidence for the existence of mirror neurons in the human brain*. The only evidence available is of higher metabolism in an area that is suggested to be homologous to the macaque area F5 . Thus, we have an idea, but no data. Mirror neurons belong to a big family of sensorimotor neurons housed by the premotor cortex. They are tuned to our own and others' actions, just as canonical neurons are tuned to objects (Rizzolatti & Fadiga 1998) and other premotor neurons (lacking a catchy name) are tuned to space (e.g., Graziano & Gross 1998). Macaque studies from the last two decades strongly suggest that premotor neurons are generally relevant for all kinds of interaction with our environment, including "other individuals" (§69), be it in the context of action planning or in the context of merely paying attention to our environment (cf. premotor theory of attention, Rizzolatti et al. 1987).

7 Merely as an aside note, the target article's way of using the notion of an anticipatory drive appears at many points in the form of the *breath of life*. To pick out only one of many examples, "a self-representation … allows the anticipatory drive to distinguish self from other" (§63). Similar metaphorical use of neurons and the brain as agents doing this and that (e.g., in §66 "Because the brain recruits its own behavior control system to represent the behavior of others, it needs to be able to distinguish self from other behavioral codes," or in §65 "mirror neurons distinguish between different behavioral intentions") should definitely be avoided, particularly when we aim to bridge gaps between philosophical, psychological and neurocognitive accounts. When loop-shaped internal model accounts of motor control are discussed and brain studies are cited, it does not seem tenable to speak in a naïve manner about systems in the (brain) system *controlling*, *representing*, *deciding*, or the like; otherwise, we face the homunculus problem and step into an infinite regress. Brains (or neurons) are not persons, nor is the anticipatory drive. Personalization is suspect since it may generate pseudo-solutions when trying to elucidate the function of complex systems.

A Computational Linguistics Perspective on the Anticipatory Drive

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1 In this commentary to Martin V. Butz's target article I am especially concerned with his remarks about language (§33, §§71–79, §91) and modularity (§32, §41, §48, §81, §§94–98). In that context, I would like to bring into discussion my own work on computational models of self-monitoring (cf. Neumann 1998, 2004). In this work I explore the idea of an anticipatory drive as a substantial control device for modelling high-level complex language processes such as self-monitoring and adaptive language use. My work is grounded in computational linguistics and, as such, uses a mathematical and computational methodology. Nevertheless, it might provide some interesting aspects and perspectives for constructivism in general, and the model proposed in Butz's article, in particular.

2 The understanding and production of natural language is often interleaved in many situations of language usage. For example, humans *monitor* what they are saying and how they are saying it. They already plan and *revise* what they are going to say before they actually spell it out, e.g. in order to reduce the risk of misunderstandings (of course, depending on the degree of attention). Or they try to *control* the generation of un-