are in the form “representation of X” (or the equivalent “X representation”), where X is mostly one of the following 7 concepts: self, goal, state, bodyspace, body, object, entity. In all these cases, the mentioned distinction between the functional and the device levels could be well expressed by using either “mental construct” or “mental operation” for the functional level and “implementation” for the device level (brain). Table 1 presents some examples of original sentences and, for each, two possible reformulations.

1. 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.

2. 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 (Glaserfeld 1995: 98): figurative elements are abstracted from sensorimotor experience; operative elements (for example conceptual relations) are constituted of attentional operations.

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.

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 unambiguous utterances (presupposing that the underlying message is as clear as possible). They can adapt themselves to the language use of others (by mutually synchronizing the individual activation of each interlocutor). For example, in the case where new ideas have to be expressed for which no mutually known linguistic terms exist (e.g., in situations of information exchange between experts and novices), the speaker’s adaptability to the hearer’s use of language is necessary in order to make it possible for the hearer to understand the new information. Humans are also good at completing the production of an utterance that was started by the interlocutor (“Oh, I know what you are going to say!”), and they are quite good in filling gaps in utterances (as presented in some psycholinguistic experiments, or similar language games).

It is also a wide-spread assumption that understanding and production share a grammatical database (“the language we speak is the same as the language we understand,” as remarked by Pinker 1994). The idea of representing grammatical knowledge only once and using it for performing both tasks seems to be quite plausible, and there are many arguments based on practical and psychological considerations for adopting such a view, e.g., Ristad (1993), Kuhn (2000), Evans et al. (2007). Furthermore, developments in constraint-based grammar theories – due to their declarative and formal status – demonstrate that grammar reversibility is computationally feasible.

In my computational model of language processing, I propose and realize (through a concrete computer program) a consequent approach to grammar reversibility through a model for interleaving parsing and generation on the basis of a uniform grammatical processing model. This model uses a reversible mechanism for interleaving parsing and generation in order to model interactions in which both understanding and production take place, e.g., monitoring, revision, and anticipation feedback loops.

If we distinguish two principle ways of interleaving, namely where generation is used in support of parsing, and where parsing is used in support of generation, then interleaved parsing and generation means a) the use of one mode of operation for monitoring and controlling the other, and b) the use of structures resulting from one direction directly in the other direction. For example, during parsing of an utterance, generation can already take place for the just-parsed parts, by taking into account the parsing results at a very early stage of processing. Self-control of the parsing process through interleaved generation is also important for handling under-specified or ill-formed input where generation is used to “guess” the missing parts or to perform some sort of repair work (e.g., to “guess” what the ill-formed utterance probably means). During natural language production, interleaved parsing is important to obtain hearer-adaptable production of utterances. The basic task of mon-
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Günter Neumann

01 Noting is to gain information about processing that is not necessarily obvious, i.e., a device is called up that can make this information available to the speaker or the hearer. Clearly, additional knowledge or preference-based mechanisms are needed for the realization of its full functionality, so that interleaved parsing and generation is only one step in that direction — but it is, however, a substantial one.

02 Considering linguistic objects (i.e., words and phrases) as utterance-meaning associations (cf., e.g., Chomsky 1995) is widely accepted. Thus viewed, a grammar is a formal statement of the relation between utterances of a natural language and representations of their meanings in some logical or other artificial language, where such representations are usually called logical forms (Shieber 1993). Thus a reversible grammar defines a common interface for parsing and generation on the level of strings (I consider a string to be an underspecified normalized representation of an utterance) and logical forms. If the assumption that human communication has access to an infinite set of meaningful utterances is true, the grammatical search space can only be defined implicitly by finite means. This is why “un-compressing” the search space for some input need to be done on-line by a computational and compositional process in order to master the combinatorial power of a grammar.

03 Usually (at least in computational linguistics) the grammar has a modular status. Grammar modularity means that the grammar is not distributed across or shared by different components of the natural language system, but rather is located in a designated area of the natural language system — the grammar module. Other components or processes do not have any detailed grammatical knowledge, and communicate with the grammar module only by its interface levels (usually abstract phonological and semantic representations). Note that grammar reversibility and modularity can also be viewed from the point of view of declarative and procedural knowledge sources, such that grammar reversibility requires a specification of grammatical knowledge that is independent from its actual use either during parsing or generation. Note also that consequently parsing and generation (considered from a competence view) are non-deterministic processes, i.e., without any further (non-grammatical) information both processes have inherent degrees of freedom: cf. also Shieber (1993). Furthermore, the mentioned properties (reversibility, implicit search space, and modularity) are also important in the context of the “recursion-only hypothesis” discussed by Hauser, Chomsky & Fitch (2002), who claim that recursion (i.e., providing the capacity to generate an infinite range of expressions from a finite set of elements) is the only uniquely human component of the faculty of language.

04 However, at least from a language usage perspective, concrete language utterances seem to be deterministic, i.e., at some point some decisions are made. What is the nature of these decisions, if they are not grammatical? At least two possibilities can be considered: either the decisions are based on preferences (which are learned through past experience) or through control, i.e., explicit strategies that are used to interpret the results of other processes in order to provide feedback. I consider preferences as “un-intelligent” in the sense that they are merely applied (blindly) and control-strategies as “intelligent” because they are applied purposely. Of course, both aspects are somewhat integrated, i.e., language processing is both preference-directed and controlled. It seems that the interleaved approach and the anticipatory drive at least have important properties that classify them an as explicit control-strategy.

05 As already said at the beginning, the proposed computational model is mainly rooted in mathematics and computational linguistics and does not claim any cognitive “realism”. However, the realization of the underlying ideas (i.e., grammar reversibility, uniform parsing and generation, self-monitoring) on such a technical algorithmic level requires fine-grained details. Furthermore, the idea of the interleaved approach of parsing and generation is also strongly motivated by the assumption that complex anticipation feedback loops are necessary for the modelling of highly self-adaptive natural language systems. And as such, it might be of interest for the further outline of the model of the anticipatory drive proposed by Butz, especially concerning the aspects of language and modularity. Clearly, the computational model in its current form is realized on a high symbolic level. Probably, it is too high to integrate it directly on a neuronal level. Seen as such, it could be of scientific interest to explore a) how to integrate sub-symbolic approaches into such computational models as I have outlined, and b) how to integrate such complex symbolic interactions into the model of the anticipatory drive.