

Human Grammatical Coding: Shared structure formation resources for grammatical encoding and decoding

Gerard Kempen

kempen@fsw.leidenuniv.nl

Leiden University & Max Planck Institute for Psycholinguistics Nijmegen

Language production and language comprehension both involve the on-line formation of conceptual and syntactic structures. These processes may be called grammatical encoding (structure formation during production) and grammatical decoding (parsing and interpreting). (In this paper, we disregard morphological, referential and lexical retrieval processes.) It is standardly assumed that the cognitive system of human language users contains separate processing components for these tasks—components with very different operating characteristics (although both rely on a single grammar and lexicon). This assumption is typically justified by the widely divergent task demands the two components have to face. For instance, dealing with ambiguity is a major concern for grammatical decoding but not for grammatical encoding; and linear order is given in the case of grammatical decoding but has to be computed on-line during grammatical encoding. Let us call this the heterogeneous dual-processor model.

However, psycholinguistic research has uncovered substantial similarities between grammatical encoding and decoding:

- Similar control structures: E.g., both processes can be characterized as lexically guided, incremental, near-deterministic, and constraint-based.
- Similar empirical profiles: E.g., syntactic priming affects the two processes in similar ways, and so does grammatical (in)congruence.

In order to account for these and other commonalities, it has been proposed that the two heterogeneous processors share their working memory. This proposal is unsatisfactory, though, because it does not address the control structure similarities. Instead, two alternative theoretical options look more promising:

- The *homogeneous dual-processor model*: The grammatical encoding and decoding tasks are carried out by two exemplars of the same type of grammatical processor; and
- The *single-processor model*: Grammatical encoding and decoding are two "modi operandi" of one and the same processing component.

How to tell these alternatives apart experimentally, in particular the single-processor model from the dual-processor models? The former model predicts that processing capacity recruited for encoding purposes cannot be assigned to decoding, and vice-versa. On the latter models, encoding and decoding activities draw on independent (non-shared) processing resources. Now suppose we can design a task that requires the participants to encode and decode simultaneously, without implicating divided attention (e.g., without having to monitor two input channels or to deal with two meanings at the same time). As grammatical structure formation is standardly considered to be an automatic process that does not require conscious attention, the dual-processor models predict that structure formation can take place in the encoding and decoding components in parallel without the need to share processing capacity. (Theories of self-monitoring during speaking usually work from this assumption, e.g., the perceptual loop theory.) The single-processor model predicts that the larger the processing capacity assigned to one of the two tasks, the smaller the amount left for the other.

In the mixed encoding/decoding paradigm that we have explored, participants perform a kind of "slow-motion shadowing" task. In each trial, they read a sentence that is presented word-by-word or in fragments spanning a few words. In one variant of the task, some of the sentences contain syntactic errors. The participants are instructed to read aloud the input fragments in grammatically correct form. This requires that, for each input fragment, they decide whether the fragment can be pronounced overtly "as is", or has to undergo a syntactic modification in order to restore well-formedness. In another variant, the input sentences are well-formed but the output sentences should embody a (morpho)syntactic modification of the input. In all variants, voice reaction times are measured to each input fragment. Notice that, during any trial, there is only one input sentence whose decoding gives rise to one meaning only, and that the encoding task yields an output sentence that is a syntactic paraphrase of the input.

The pairs of an input and an output sentence are constructed in such a way that the initial sequence of input fragments leads the participants to expect different downstream fragments than the initial sequence of output fragments does. The RTs to these downstream fragments can reveal whether the actual expectations are based on the grammatical structure assembled for the perceived input fragments or on the modified structure that underlies the output sentence (or on a mixture of both).

Provisional RT patterns obtained thus far clearly indicate that, in this dual-task paradigm, the participants' expectations followed the output structures they encoded themselves, not on the initial structure of the decoded input. In a control condition (self-paced reading aloud without paraphrasing instructions), the RT pattern agreed with input-based expectations.

These data suggest, contra the dual-processor models, that grammatical encoding and decoding tasks draw on the same processing resources. In conjunction with the above task similarities, they support the idea of a single "human grammatical coder."

When presenting the paper, we hope to discuss how this idea squares with other known facts concerning grammatical encoding and decoding, in particular their interplay in self-monitoring.