Rethinking the architecture of human syntactic processing: The relationship between grammatical encoding and decoding

Gerard Kempen
Dept. of Psychology, Leiden Univ.
PO Box 9555, 2300 RB Leiden / NL
&
Max-Planck Institute for Psycholinguistics
PO Box 310, 6500 AH Nijmegen / NL
kempen@fsw.leidenuniv.nl

Karin Harbusch
Computer Science Dept., Univ. Koblenz
Rheinau 1, 56075 Koblenz / DE
harbusch@uni-koblenz.de

Rethinking the architecture of human syntactic processing:
The relationship between grammatical encoding and decoding

In linguistics and psychology it is standardly assumed that the cognitive architecture underlying human syntactic processing in sentence understanding and sentence production includes two modules, a parser and a formulator (henceforth ‘grammatical decoder’ and ‘grammatical encoder’), which operate in different directions. The decoder takes as input a string of lemmas (syntactically specified lexical items) and produces as output a syntactic structure which is semantically interpreted; the encoder takes a semantic structure as input and generates a lemma string as output. This opposite directionality is often taken to imply that the two modules use radically distinct mechanisms of syntactic structure formation.

However, closer inspection reveals that the modules have a great deal in common. Encoding and decoding both involve the assembly of intimately linked syntactic and conceptual structures. Differences are restricted to the input channel that initiates and controls the assembly process, and the output delivered. The *internal structures* computed by the two modules are highly similar. Adopting the Performance Grammar formalism (Kempen & Harbusch), we propose to characterize them as *unordered* hierarchies of *case*-marked lemmas (syntactically specified lexical items; case-marks may be absent). The lemmas are connected by grammatical functions (subject, head, direct object, modifier, etc.) annotated with *positional features* and *conceptual links*. These annotations enable both modules to check the quality of the output-under-construction against the input in an 'analysis-by-synthesis' style. Positional features and case-marks enable the derivation of output strings. During speaking, these strings initiate subsequent phonological encoding; during sentence comprehension, they are checked against input strings. The conceptual links enable the derivation of conceptual structures. In sentence comprehension, these are the starting point of semantic interpretation. During sentence production, they are checked against the to-be-expressed conceptual structure (the 'preverbal message').

The similarity of the hypothesized internal structures built and maintained by encoder and decoder predicts that the structure assembly processes are similar as well. A growing body of experimental psycholinguistic evidence indeed testifies to this. The two modules respond similarly to conceptual / contextual factors, subcategorization frame preferences, syntactic priming, and complexity variables. They both can build sentences incrementally and are liable to making similar types of agreement errors.

These and other resemblances between the inner workings of encoder and decoder, in turn, suggest two theoretical alternatives to the standard architecture:

- Our cognitive architecture contains two exemplars of the *same* syntactic structure assembly mechanism, one for encoding, one for decoding
- There is only one exemplar of a such a mechanism, a 'grammatical coder', which can switch between input channels and thus between encoding / decoding.

The latter option has the advantage of greater theoretical parsimony and deserves priority if it does not fall behind its competitors in terms of empirical coverage.

An important prediction from the single-coder hypothesis is that encoding and decoding activity cannot take place simultaneously. At first sight, this contradicts the Perceptual Loop hypothesis which holds that the well-formedness of speech output is monitored on-line by the speaker's own decoder (Levelt, 1989). This conclusion is premature, though, for three reasons. First and foremost, recent studies of the effects of time pressure and reduced processing capacity on self-monitoring performance do not square well with the Perceptual Loop hypothesis (see Postma, 2000, and Oomen & Postma, 2001, for details). Second, the coder (in decoding mode) can check past speech output (inner or overt speech) that is temporarily stored in a buffer. This does not require true simultaneity of encoding and decoding if the coder can switch between encoding an decoding modes (cf. 'time-sharing'). Third, on the theory outlined above, checking the output-under-construction against current input is part and parcel of both encoding and decoding. Viewed in this light, self-monitoring is an intrinsic part of the grammatical encoding process itself.

In the final paper, we will sketch how a single grammatical coder embodying Vosse & Kempen's (2000) competition-based model of syntactic tree formation can handle the recent self-monitoring data.

References

KEMPEN, G. & HARBUSCH, K. (in press). Word order scrambling as a consequence of incremental sentence production. In: Härtl, H., Olsen, S. & Tappe, H. (Eds.), *The syntax-semantics interface: Linguistic structures and processes*. Berlin: De Gruyter.

KEMPEN, G. & HARBUSCH, K. (forthcoming). Dutch and German verb clusters in Performance Grammar. In: Seuren, P. & Kempen, G. (Eds.) *Verb clusters in Dutch and German.* Amsterdam: Benjamins.

LEVELT, W.J.M. (1989). *Speaking: From intention to articulation.* Cambridge MA: MIT Press.

OOMEN, C.C.E. & POSTMA, A. (2001). Effects of time pressure on mechanisms of speech production and self-monitoring. *Journal of Psycholinguistic Research, 30,* 163-184.

POSTMA, A. (2000). Detection of errors during speech production: a review of speech monitoring models. *Cognition, 77,* 97-131.

VOSSE, T. & KEMPEN, G. (2000). Syntactic structure assembly in human parsing: A computational model based on competitive inhibition and a lexicalist grammar. *Cognition, 75*, 105-143.