Decay and interference in human sentence processing

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Locality-based parsing theories of human sentence processing assume that increasing the distance between a verb and its arguments makes processing harder at the verb: the more distant the arguments, the harder their integration with the verb. One such theory, Gibson's (2000) Discourse Locality Theory (DLT), quantifies increased distance explicitly in terms of the number of intervening discourse referents.

However, a plausible alternative explanation for distance effects is decay *per se* and/or similarity-based interference (Lewis 1996). Recently conducted self-paced reading studies (Vasishth, 2003) suggest that (a) when distance (as defined in DLT) is increased but decay of the predicted parse-tree is arrested or reversed (by increasing activation due to repeated retrievals), increasing distance can in fact *facilitate* processing; and (b) similarity-based interference is an independent factor affecting parsing difficulty (apart from activation decay).

To explore the role of activation decay more precisely, a parsing model was implemented within the cognitive architecture ACT-R. The ACT-R architecture was chosen because it incorporates a decay and interference theory applicable to a variety of cognitive phenomena. We show that using ACT-R's default decay and interference parameters provides a compelling, cross-linguistically robust explanation for the observed complexity effects.

The model incorporates a left-corner parser (Resnik 1992) with no lookahead: syntactic structure is incrementally built bottom-up and top-down. As described above, the activation decay and reactivation of incrementally constructed syntactic structures facilitates processing. In addition, when a verb

is processed any previously seen arguments are retrieved and integrated with the verb. Consequently, the further away these arguments are, the greater their activation decay, and the longer the retrieval time at the verb.

The ACT-R model is designed to perform a simplified version of the self-paced reading task. Since it is integrated with ACT-R's independently motivated assumptions regarding visual processing and motor actions, the model has the further advantage that reading times are obtained using a mechanism closely approximating self-paced reading as performed by human subjects.

In sum, we provide an alternative explanation of distance effects in terms of activation decay. Moreover, distinguishing interference and decay in this way makes it possible to provide a principled interference-based explanation for why very long subject NPs like *the man* in *The man walking the dog under the bridge next to the water tower frightened the child* can actually be easier to process than short ones, cf. the same NP in *The child that the man that the dog chased frightened ran away*, if this renders the NP less similar to other NPs. More generally, this research shows that ACT-R's broadly applicable cognitive constraints provide a precise, cross-linguistically valid account of human parsing processes.

References

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