

## A connectionist model of graded effects in local syntactic coherence interpretation

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Sentences can contain sequences of words that – in isolation – have an interpretation deviating from the interpretation of the global sentence context they are embedded in (see (1)). These local syntactic coherent (LSC) sequences influence both reading times (Tabor, Galantucci, & Richardson, 2004) and fixation patterns in visual-world experiments (Konieczny, Müller, Hachmann, Schwarzkopf, & Wolfer, 2009). The latter showed that in sentences like (1) participants' fixations are drawn to scenes depicting the (globally incorrect) meaning of the embedded sequence '*die Astronautin überrascht den Außerirdischen*' (the astronaut surprises the alien). These effects provide strong evidence against self-consistent parsing models and are in favor of self-organized dynamical system approaches of language processing (Tabor et al., 2004), where local transitions influence processing regardless of global consistency. We provide a connectionist (SRN) model that can account for the patterns found in the visual-world experiment. In addition, the model predicts a graded influence of part-of-speech bias of the ambiguous elements (*überrascht*) on the effects. A reanalysis of the visual-world data revealed similar bias effects in the fixation patterns.

Simple recurrent networks were trained with different combinations of training parameters for 100 epochs of 20000 sentences, generated by a simplified PCFG of German that included ambiguous elements, thus allowing various types of sentences, among them clauses resembling the materials of Konieczny et al. (2009). The networks performed better than 7-grams in long distance number agreement. However, where global (1a) and local (1b) predictions diverge maximally, as at the relative-clause verb, the networks still elicited locally coherent false alarm activations of an end of sentence (EOS) in addition to the most strongly activated correct elements. Moreover, the amount of false-alarm EOS activation was modulated by the part-of-speech bias of the ambiguous element: EOS activation was higher when the ambiguous element occurred more often as a finite verb.

To test the latter modeling result empirically, we calculated the finite-verb-bias for the ambiguous elements in Konieczny et al.'s (2009) stimuli as the tendency to occur as a finite verb (the locally coherent reading) divided by the overall frequency of the element. Linear mixed-effect modeling reveals a significant interaction of finite-verb bias with local coherence: fixations on the local scene are more likely the higher the finite-verb bias, but not in a control condition containing the ambiguous element but no LSC (2), proving the context-dependency of the effects and ruling out a purely lexical explanation (Gibson, 2006).

Our SRN-model can account for the general patterns of local syntactic coherence effects, and, in addition, predicts graded bias-effects that were approved in visual-world data. The results provide support for dynamical system approaches to language processing.

- 1) Hans, dem [die Astronautin überrascht den Außerirdischen] zeigt, sieht das Raumschiff .  
 Nnom, RP<sub>dat</sub> [DET N<sub>nom</sub> ADV<sub>ambig</sub> DET N<sub>akk</sub>] V<sub>finite</sub>, V<sub>finite</sub> DET N<sub>akk</sub> EOS  
 Hans, whom the astronaut (surprised)/surprisedly the alien shows, sees the spaceship .  
 '*Hans, to whom the astronaut shows the alien surprisedly, sees the spaceship.*'  
 a. 6-gram prediction: EOS (and others)  
 b. globally possible: V<sub>finite</sub> only
- 2) Hans, dem [die Astronautin äußerst überrascht den Außerirdischen] zeigt, sieht das Raumschiff .  
 Nnom, RP<sub>dat</sub> [DET N<sub>nom</sub> ADV ADV<sub>ambig</sub> DET N<sub>akk</sub>] V<sub>finite</sub>, V<sub>finite</sub> DET N<sub>akk</sub> EOS  
 Hans, whom the astronaut very (surprised)/surprisedly the alien shows, sees the spaceship .  
 '*Hans, to whom the astronaut shows the alien very surprisedly, sees the spaceship.*'  
 a. 6-gram & global prediction: V<sub>finite</sub> (no local coherence)

### References

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