Cross-linguistic acquisition of complex verb inflection in a connectionist model
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Usage-based approaches to language learning suggest that the acquisition of inflectional morphology and errors made by young learners are a function of the statistical properties of the input (e.g., Bybee & Moder, 1983). It has been shown that purely exposure-based computational models such as neural networks can acquire English verb and noun inflection (e.g., Plunkett & Juola, 1999) and also the complex system of Serbian noun morphology (Mirković, Seidenberg, & Joanisse, 2011).

We investigated to what extent a single exposure-based mechanism can predict human error patterns in the acquisition of verb inflection for the two morphologically complex and dissimilar languages Polish and Finish. Polish inflectional suffixes are highly complex compared to a fairly regular system in Finnish. On the other hand, Finnish features more complex stem alternations than Polish. We trained neural network models on the task of producing person/number inflected present-tense verb forms in Polish (PL) and Finish (FI) and compared the simulations with experimental results of elicited-production studies with children at the age of about 50 months.

Three-layer network models were presented with phonological representations of verb stems (e.g., PL: /r₁suj/; FI: /roik:u/) together with a code for one target person/number context on the input layer and were trained to produce the inflected form on the output layer (e.g., PL: /r₁sujEs/; FI: /roikut/ for 2nd singular). In each language, 800 present-tense verbs (PL: 2419 forms; FI: 1785) were presented probabilistically during training according to their token frequencies in child-directed speech corpora. By limiting the intermediate layer to 200 units, the models were forced to generalise rather than rote-learn by extracting regularities in the input.

The models could correctly inflect over 99% of the trained verb forms after seeing 500,000 (PL) and 250,000 (FI) examples and correctly generalised 96% (PL) and 90% (FI) of unseen tokens. Both models showed faster and more accurate acquisition for inflected forms with a high token frequency and with high phonological neighbourhood density (PND; a measure of phonological analogy). Suffix errors often resulted from overgeneralisation (i.e., producing the correct person/number context but from a different inflectional class) and occasional substitutions of low-frequency forms with higher-frequency forms (e.g., producing 3rd singular instead of 1st singular). These results are consistent with our experimental findings. In addition, the simulations showed an interaction between frequency and PND in certain training stages, such that low-frequency forms benefited more from PND than high-frequency forms. This interaction was, however, not significant in the experimental data.

Our results suggest a common cross-linguistic learning mechanism underlying the acquisition of inflectional morphology that is sensitive to subregularities in the input. We discuss cross-linguistic differences and detailed error patterns at different training stages.