A model of word meaning inference development in children

Takayuki Shimotomai †, Graduate School of Engineering, Hokkaido University
Takashi Omori ‡, Graduate School of Engineering, Hokkaido University

E-mail: taka@complex.eng.hokudai.ac.jp †, omori@complex.eng.hokudai.ac.jp ‡

Word meaning inference development

It is an important problem to elucidate how an infant learns their own language. Many researchers in developmental psychology have reported evidence of language learning in infants. However, the computational aspect of this learning mechanism is not yet well understood. Recently, Elman et al. have argued for the development of language by the connectionist model, but their claims have a gap between their models and the behavioral experiments of the children. Therefore, in this paper we present new computational concepts derived from experimental data by using model-based analysis.

The early-stage learners of language learn their own language with amazing speed. In this period, it is assumed that they not only learn each word but also acquire meta-rules, the learning rules for new words. Using a rule, a child can map a new word to a meaning quickly and then learn the complex language we speak. In this study, we focus on the acquisition of verbs and nouns. In the literature, it has been reported that a 3-year-old infant can expand a given word to proper objects according to the object’s property. However, for verbs, Imai et al. reported that 3-year-olds tend to fail to expand a verb to the action while 5-year-olds tend to expand it to the proper action. In this paper, we examine children’s verb acquisition ability and we analyze the data of verb meaning inference based on the hierarchical model of Jordan and Jacobs. From the result, we show the change in the computational process for word acquisition along with age and other parameters.

Experiments of word meaning inference

Phenomenally, infants can almost immediately learn a new word in connection with the meaning when the word is given with a visual stimulus. It’s not an easy problem to determine which part we should map the word to. We examined the verb acquisition ability of children. We prepare the Standard, Action Changed (AC) and Object Changed (OC) stimuli. We showed children AC and OC stimuli after Standard stimuli. In Standard, we told the subject a new verb word and asked which the word is. As the results, subjects tended to chose AC or OC stimuli consistently in the experiments. Therefore, we analyzed the data as a hierarchical model (Figure).

Model-based Analysis of the data

We analyzed the experimental data with a mixture-of-binomial-distributions model.

\[ p_x(k, z) = \sum_{n=1}^{N} z_n g_n B_n(k) \]

We used an EM algorithm for fitting the model parameters to the data. We show that a hierarchical model is appropriate for analyzing the data of verb meaning inference experiments by statistical estimation and evaluation of AIC.

We show that not the module but the gating parameters probabilities change. So we conclude that failure in verb meaning inference is due to the inability of infants to select the appropriate rule.

Figure. Hierarchical system model for verb and noun meaning inference