Negative Evidence Drives Lexical Development

Alexandra Schaffert (ALSCHAFF@INDIANA.EDU)
Michael Gasser (GASSER@INDIANA.EDU)
Linda B. Smith (SMITH4@INDIANA.EDU)
Department of Psychology and Program in Cognitive Science
Dept. of Psychology, Indiana University, Bloomington, IN 47405 USA

The Naming Explosion

Children produce their first words just before their first birthday. During the next 6 months they add words to their productive vocabulary slowly - one at a time. Around 18 months, there is a sudden increase in word productions, often referred to as the naming explosion.

Under- and Overextensions in Production and Comprehension

Several investigators have reported that for a limited time during this initial increase in word productions, children often misuse or metaphorically use words. For example, they might overextend the word "moon", applying it to fingernails, orange quarters, and plates (Macnamara, 1982). We explain the fall and rise in under- and overgeneralizations in early production and comprehension in terms of the pattern of positive and negative evidence that children receive about word meanings.

Children Receive Positive and Negative Evidence

Students of word acquisition generally agree that children receive only positive evidence about what objects are called and do not receive negative evidence. Put simply, parents tell children what things are ("This is a plate") and do not tell them what things are not ("This is not a moon"). Parents only provide negative evidence when the child makes a mistake. Thus, for example, a child finds out that plates are not called moons by calling a plate "moon" and subsequently being told by the parent that "This is a plate, not a moon".

Testing the Influence of Negative Evidence

Using a two-group design, we tested the influence of negative evidence on children's overgeneralization errors. In weekly sessions, children were taught novel names for novel categories. One group of children did receive negative evidence, the other group did not receive any kind of feedback. At the end of each session, we tested their word production and comprehension, using novel exemplars as well as non-category members. The distinct trajectory of word production and comprehension errors generated by each group can be explained by the differential feedback that the children received.

A Neural Network Model

We instantiated this kind of feedback in a connectionist network and showed that it yields an initial period of slow acquisition, followed by a fast rise in new word productions and errors, and then a decline in errors with a continued rise in new word productions. The network consisted of three layers: an object layer, a hidden layer, and a word layer. The important aspect of the network is the manner in which it learns. We employed a modified version of contrastive Hebbian learning such that targets are determined by the network's response.

A Developmentally Plausible Learning Algorithm

The learning algorithm spontaneously generates the observed developmental trend. Early in learning the network makes few responses because few outputs are activated above threshold. The network thus receives only positive evidence. This positive evidence causes individual outputs to be increasingly activated by a wide variety of inputs. At this point, even completely novel inputs may push an output's activation above threshold. The resulting increase in the network's 'productions' places the network in a position to receive both positive and negative feedback. This causes even more rapid word learning and a decline in errors, both in production and in comprehension.

Epigenesis: Learning Systems Generate New Learning Environments

These results are theoretically important for several reasons: First, they offer an explanation of why the developmental trend in naming shows the particular nonlinear patterns that it does and it shows how early overgeneralizations may be an integral part of the developmental pathway toward rapid word acquisition. Second, the specific explanation shows how nonlinear developmental patterns may result from a single system that places itself in different learning environments as it develops. Third, the explanation offers a developmentally plausible learning algorithm that may prove generally useful.

References

Macnamara, J. (1982). *Names for Things.* Cambridge, MA: MIT Press.