Modeling the Role of Phonetic Knowledge in Learning to Read Aloud

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Introduction

When learning to read, a child must develop a mapping from orthography to phonology; that is, from the letters of the word to the correct pronunciation of the word. Although the ultimate goal of reading is comprehension and extraction of the message of the text, to become a fluent reader of English the young child must grasp the alphabetic nature of the language and must develop a fluent and reflexive knowledge of spelling-sound correspondences in order to read with any measure of skill (Adams 1990). Most computational models of reading assume that the phonological form plays a passive role as a static mapping target. However, the child certainly has substantial knowledge of phonological structure before learning to read. Here, we consider what effect that knowledge might have on learning.

Connectionist models of reading (Seidenberg & McClelland 1989; Plaut, McClelland, Seidenberg & Patterson 1994; Plaut & Shallice 1993) have so far addressed many psychological phenomena associated with reading. However, none of these models has addressed how pre-existing knowledge affects the learning process. Recently, Plaut *et al.* (1994) sought to explain the cause of acquired surface dyslexia by training their orthography-to-phonology pathway in the face of an additional "semantics" input. Brain injury is then simulated by removing the additional input; this damaged network produces results consistent with actual dyslexia data. However, the model does not give a realistic account of the process of learning the semantics-to-phonology pathway (nor was it meant to).

Interactions of Learning in Stages

This work concentrates on the effect of learning these aspects of language in stages in a connectionist model of the reading process. We imagine that before learning to read one already has the meaning-to-phonology association, which consists of two components: the semantics-to-phonology mapping and the phonological attractor itself. We investigate the effects of simply having knowledge of the phonological structure of English, modeled through the use of an attractor at the phoneme layer. This phonological attractor is trained with a representative sample of English one-syllable words and is intended to learn regularities which appear in the language and to clean up any noisy or ambiguous input into a valid (American) English pronunciation. The orthography-to-phonology pathway is then trained in the presence of these recurrent phoneme weights; the feedforward portion need only place the network into the appropriate attractor basin and the recurrent links will carry the network activation to a valid pronunciation over subsequent network iterations.

We use these networks to investigate the Phonics method of reading instruction. In the Phonics method, correspondences between printed letters and phonemic sounds are learned in isolation from their context within words. To simulate this, the orthographic feedforward pathway was initialized with random weights and then given some training with a small set of grapheme-phoneme correspondences outside of their context within words. For instance, a typical training example might indicate that the letter t should map onto the phoneme representation for /t/.

Once the orthographic pathway had been exposed to the phonics training set, several simulations were run with these weights. This orthographic net was combined with various configurations of phoneme attractors; these networks and an additional network without any phoneme attractor were then all trained on the full grapheme-to-phoneme training set. Those networks with phoneme attractors did not change the weights of the attractors, although the effects of error propagation through those weights was explored. The networks which combined both the preliminary Phonics training and a phonological attractor were seen to learn fastest. This supports the notion that prior information about the phonetic structure of the language to be learned encourages faster learning of the reading task.

The main goal for the next phase of this project is to incorporate semantic information into training of the feed-forward networks and observe the effect on the learning curve, and to examine the effects of network damage on the network with incorporated semantics and compare the subsequent performance to actual dyslexic subject data.

References

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