Serial Order in Reading Aloud: Connectionist Models and Neighborhood Structure

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Overview

Dual-Route and Connectionist models of reading have been at odds over claims as to the correct explanation of the reading process. Recent Dual-Route models show a position-of-irregularity latency effect (corroborated by subject data) for which it is claimed single-route connectionist models cannot account. A refutation of this claim is presented here, consisting of network models which do show the rank-order phenomena, plus orthographic neighborhood statistics which explain the origin of the effect.

In the DRC model (Coltheart and Rastle, 1994), input is activated in a left-to-right fashion to simulate the reading direction of English. Activation from both the Grapheme-Phoneme Correspondence (GPC) rule route and the lexicon route will thus begin to interact at the early phonemes first. For words with irregular pronunciation, information conflicting between the lexical and GPC routes will activate different phonemes, causing words with inconsistencies to be pronounced more slowly. With feedback to the lexicon, words with irregularities in the early phoneme positions will have more conflict and delay than words with ending phoneme irregularities, with a linear ordering by position.

In contrast to the claims of the dual-route advocates, several connectionist systems have been developed to model the orthography to phonology process (Plaut et al., 1996). These connectionist models provide evidence that the task, with accompanying phenomena, can be learned through a single mechanism. The networks used here are based on the feed-forward networks of Plaut *et al.*

Experiments and Results

For networks, latency is measured by output mean squared error (MSE) of exception versus regular control words. For the statistical neighborhood, Taraban & McClelland neighborhoods are defined as words containing the same vowel grouping and final consonant cluster, while Edit-Distance-1 neighborhoods are those words which can be generated from the target word by making one change: either a letter substitution, insertion or deletion. For each phoneme position we compare each word with irregularity at that position with its neighbors, counting the number of enemies (words with alternate pronunciation at the supposed irregularity) and friends (words with pronunciation in agreement). The Ratio column represents the value of (same pronunciation) / (same + different).

Both 2-syllable test words and their controls are those found in (Coltheart and Rastle, 1994). The 2-syllable network appears to produce approximately the correct linear trend in the naming MSE/latency (Figure 1), although the results displayed are not monotonically decreasing with position. However, neither are the results presented by Coltheart, when each experiment is taken separately. For correct analysis, several "subject" networks should be trained, with formal linear trend analysis then performed with the resulting data. These further simulations are currently being undertaken.

Table 1: Average Statistical Neighborhoods

	Same Pronunciation	Enemies	Ratio
Taraban&McClelland	(1 syllable)		
Position 1	0	17	0
Position 2	0.54	8.17	0.06
Position 3	1.33	7.33	0.15
Edit-Distance 1	(2 syllable)		
Position 1	0	.9	0
Position 2	.6	3.4	.15
Position 3	.59	.94	.38
Position 4	.74	.86	.46
Position 5	.5	.5	.5

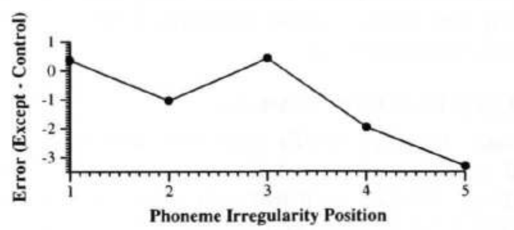

Figure 1: 2-syllable network latency differences

References

Coltheart, M. and Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual route models of reading. *Journal of Experimental Psychology: Human Perception and Performance*, 20(6):1197–1211.

Plaut, D., McClelland, J., Seidenberg, M., and Patterson, K. (1996). Understanding normal and impaired word reading: Computational principles in quasi-regular domains. *Psychological Review*, 103(1):56–115.