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Stressing what is important: Orthographic cues and lexical stress assignment

Nada Ševa [a,*], Padraic Monaghan [b], Joanne Arciuli [c]

[a] *Department of Psychology, University of York, YO10 5DD, UK*
[b] *Department of Psychology, Lancaster University, UK*
[c] *Department of Speech Pathology, University of Sydney, Australia*

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Abstract

Computational models of reading have typically focused on monosyllabic words. However extending those models to polysyllabic word reading can uncover critical points of distinction between competing models. We present a connectionist model of stress assignment that learned to map orthography onto stress position for English disyllabic words. We compared the performance of the connectionist model to Rastle and Coltheart's [(2000).] rule-based model of stress assignment for words and nonwords. The connectionist model performed well on predicting human performance in reading nonwords that both contained and did not contain affixes, whereas the Rastle and Coltheart model performed well only on nonwords with affixes. The connectionist model provides an important first step to simulating all aspects of polysyllabic word reading, and indicates that a probabilistic approach to stress assignment can reflect human performance on stress assignment for both words and nonwords.

Keywords: Connectionist model of stress assignment

* Corresponding author. Tel.: +44 1904 433177; fax: +44 1904 43318.
E-mail address: nadaseva@gmail.com (N. Ševa).

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1. Introduction

Computational modelling has enabled links to be forged between neural structure and cognitive processes (see, e.g., Monaghan & Shillcock, in press; Rogers & McClelland, 2004). Computational models have also facilitated insight into the cognitive categories involved in particular tasks. Particularly insightful in this respect have been models of single word reading, where proposals for the precise mechanisms involved in mapping written words onto spoken forms have been tested (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Seidenberg & McClelland, 1989). Yet, these previous computational models of reading have concentrated on determining the mapping from letters, or sets of letters, onto phonemes, or sets of phonemes. In this paper we review the implications for this restriction to phonology in comparing computational models of reading, and show that considering stress assignment in reading is an important distinguishing characteristic between alternative cognitive accounts of word processing.

There are two recent traditions for modelling the cognitive processes involved in mapping letters onto phonemes: the dual-route model, and the connectionist triangle model. The dual-route framework incorporates into the model two systems for forming the mapping between letters and phonemes. The Dual-Route Cascaded (DRC) model (Coltheart, 2000; Coltheart et al., 2001) implemented these two routes in a model of reading, with the lexical route comprising a stored lexicon containing phonological information for all the words known to the hearer, and the second sub-lexical route which applies grapheme-phoneme correspondence rules to convert serially the orthographic input into phonemes. Though the two routes operate simultaneously and in parallel, for word reading, the lexical route is configured to process the written input faster than the sub-lexical route, and so correct naming of irregular words is achieved. For nonwords, there are no entries in the stored lexicon and output from the sub-lexical route determines the pronunciation. A recent development in the dual-route framework is the CDP+ model which provides an impressive fit to item-level naming data (Perry, Ziegler, & Zorzi, 2007). The model is an adaptation of the DRC, except that the grapheme-phoneme correspondence route is implemented as an associative network that is trained on the lexicon to discover the correspondences. In the DRC model, these correspondences are rule-based and provided to the model.

A contrasting tradition in modelling reading is the connectionist triangle model, where the mapping between orthography and phonology is mediated by direct links between these representations and also connections to and from a semantic representation of words. The triangle model has been implemented, to varying degrees of completeness (Harm & Seidenberg, 1999, 2004; Plaut, McClelland, Seidenberg, & Patterson, 1996; Seidenberg & McClelland, 1989), in connectionist models where all connections between representations are learned. So, the model stores statistics about the associations between the representations, and these representations interact in the process of mapping written words onto pronunciation. The two frameworks of modelling reading have shown convergence over many aspects of their architectures, as exemplified by the incremental, nested modelling approach of CDP+, which encompasses both trained, associative networks characteristic of the triangle model tradition, as well as hard-wired localist lexical units inherited from the DRC. However, a key distinction is the nature of nonword reading in these models. In the dual-route model, pronunciation rules are applied to the graphemes of the nonword. In the triangle model, nonwords are read by analogy to similar words and parts of words to which the model has previously been exposed. This distinction proves to be critical for conceptions of how stress is applied to nonword naming, and