A developmental perspective on the neural code for written words

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Two recent TICS articles [1,2] converge on the idea that in mature reading written words are coded by an abstract neural representation comprising either “open bigrams” [2] or bigrams in combination with larger units [1]. For example, the input TAKE is represented by the units TA TK TE AK AE and KE. However, open bigrams do not map onto phonology. Because phonology is fundamental in beginning and skilled reading [3], we argue that open bigrams cannot be the full story.

Children begin “reading” written words by using salient visual cues like logos [4]. Pre-readers can identify words like PEPSI in a logo, but if the nonword XEPSI appears in the logo, it is “read” as “pepsi”. When visual cues are primary, open bigrams are not coded. Once letter names and sounds are learned, an advantage is found for simplified phonetic spellings over visually distinctive groupings of letters. Notice kindergarten readers find it easier to learn that JRF is “giraffe” and PNSL is “pencil”, than to learn that WBC is “giraffe” and QDJK is “pencil” [4]. Clearly, phonology is an integral part of creating and storing the visual codes for written words. When words have “silent” letters (B in LAMB, S in ISLAND), children require extra storage cues. In paired associate learning tasks involving the presentation of word/letter pairs, children are better at recalling words from silent letter cues than from sounded letter cues (e.g., which word went with B? – lamb) [5]. In visual search tasks, children are better at searching for non-silent letters (lamb – l). If children stored open bigrams, neither effect should occur.

Cross-language developmental data support the developmental primacy of phonology. For example, German children acquire the neural code for written words much faster than English children. These two languages have almost identical orthographic and phonological structure. If the underlying neural code developed purely to represent orthography, then the brain of a German child should require about the same time to “build” an open bigram code as the brain of an English child. It does not [6]. Optimal grain size is not determined by visual or retinal constraints, but by the transparency of the phonology-orthography mapping [3].

Priming effects interpreted as support for open bigrams also fit our proposal. Although GRDN primes GARDEN, GDRN does not [2]. This is because the scrambled prime GRDN disrupts phonological structure; the scrambled prime GRDN does not. It has also been proposed that open bigrams might only be used on the lexical route of a dual-route framework, letter-sound correspondences would then be used on the nonlexical route [7]. This solution ignores data showing that phonology affects the lexical route, such as body neighborhood effects in lexical decision [8].

In summary, the fundamental role of development in setting up a neural code for written words should not be ignored. When children learn written words, they seek orthographic units to map onto phonological units that are already represented in their brains. They optimize visual neural codes that enable consistent mappings between orthography and phonology at different grain sizes [3]. Why should the neural code for written words, created during reading development, “reset” with visual-orthographic expertise? Instead, phonology offers a unique code for serial order that is invariant under changes in location, size, case and font. The front end of visual word recognition must be shaped by phonology.

References