The orthographic representation of consonant–vowel status: Evidence from two cases of acquired dysgraphia

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Introduction

Most theories of the cognitive architecture of the spelling system include a post-lexical working memory process called the “graphemic buffer.” The buffer maintains orthographic representations (retrieved from long-term memory or assembled via the sublexical system) during the selection of output forms (letter names or shapes) for spelling (Caramazza & Miceli, 1990). Individuals with a selective graphemic buffer impairment exhibit a characteristic profile, including: a word length effect, letter errors such as substitutions, deletions, insertions, exchanges, and shifts; and the absence of a frequency effect, semantic errors, or phonologically plausible errors.

One striking pattern in certain individuals with graphemic buffer damage is a very high rate of preservation of consonant–vowel (CV) status in substitution errors (CLAW → CRAW). For example, LB (Caramazza & Miceli, 1990) preserved CV status on 99% of letter substitution errors. This pattern is difficult to explain if orthographic representations include only letter identity and position information. The high CV preservation rate (among other things) led Caramazza and Miceli to claim that orthographic representations are multi-tiered, containing a separate representation of orthographic CV status. We refer to this as the Orthographic CV proposal (see also McCloskey, Badecker, Goodman-Schulman, & Alimonti, 1994). However, Johnsdottir, Shallice, and Wise (1996) argued that it may not be necessary to posit that orthographic representations contain CV information. They suggested that basic phonological information about a word can constrain the output in cases of damage, yielding these high CV preservation rates. They did not, however, formalize this Phonological CV claim, creating a problem for testing it. We attempt to address this problem and test the alternative hypotheses in this investigation.

Fig. 1a depicts the representation of CHAIN under the Orthographic CV account with Column 1 depicting an intact representation, Column 2 one that is damaged, and Column 3 a repaired representation. The figure illustrates that the CV status of the substituted letter is constrained to be a vowel in the output, because the “damaged” letter (I) is associated with a vowel on the orthographic CV tier. Fig. 1b depicts the corresponding representations under the Phonological CV account according to which each letter is associated with its corresponding phonemes in CV status (consistent polygraphs). To empirically distinguish between these accounts, we must consider words with a mismatch in phoneme and grapheme CV status (e.g., THIGH) (mixed polygraphs). As shown in Fig. 1c and d, for these words, the two accounts make different predictions. The orthographic account predicts that the G will be substituted by a consonant, while the phonological CV account predicts that the G will be substituted by a vowel, matching the phonological CV status of the G (part of the diphthong /aI/).

In the investigation reported here, we evaluate the spelling performance of two brain-damaged individuals, examining the substitution errors produced on mixed versus consistent polygraphs. According to the orthographic CV account, CV preservation in mixed polygraphs should be no different from that in consistent polygraphs, whereas according to the phonological CV account, CV preservation in mixed polygraphs should be significantly reduced.

Case studies

RSB, a right-handed man, suffered a CVA at the age of 54, five years prior to the onset of this investigation. BWN, also a right-handed man, suffered a CVA at the age of 72, seven years prior to the onset of this investigation. Both hold PhDs, and neither had premorbid spelling difficulties. In both cases, MRI and CT scans reveal a left parietal lesion that produced moderate difficulties in spoken language production, and significant difficulties in spelling and number processing.

Analysis 1: Locus of spelling impairment

RSB and BWN exhibited the characteristics of a graphemic buffer deficit: (1) word length effects: RSB, 79% correct on four-letter words, 14% correct on seven-letter words ($\chi^2 = 9.2, p < .002$); BWN, 96.4% correct on four-letter words; 55.4% correct on eight-letter words ($\chi^2 = 23.62, p < .0001$); (2) errors consisted of letter substitutions, deletions, additions, transpositions, and shifts (CV preservation in substitution errors: 86% for RSB; 92% for BWN); (3) morphological and phonologically plausible errors were rare, and semantic errors were not observed; (4) spelling accuracy was largely insensitive to word frequency.
Analysis 2: Mixed polygraphs

Mixed polygraphs (e.g., THIGH) and control words containing consistent digraphs in the same positions (e.g., TRICK) were matched on length and frequency and administered for written spelling to dictation \( (n = 302) \).

We examined the substitution errors made on mixed and consistent polygraphs. RSB preserved the orthographic CV status of 73% of substituted letters in mixed polygraphs, and of 80% of substituted letters in consistent polygraphs \( (\chi^2 = 0.02, \text{ns}) \). BWN preserved orthographic CV status of 86.6% of substituted letters in mixed polygraphs, and of 84.6% of substituted letters in consistent polygraphs \( (\chi^2 = 0.04, \text{ns}) \).

Conclusions

The substitution errors of the two individuals largely preserved orthographic CV status. Furthermore, CV preservation rates did not differ for stimuli with a mismatch between orthographic and phonological CV status compared to control segments. These data are consistent with an account of orthographic representations in which orthographic CV status is represented, and problematic for an account of orthographic representations in which the only constraint on the CV status of substitutions comes from phonological information. Additional data collection and analysis are underway.

References