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Graphotactics and spelling: Evidence from consonant doubling

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ABSTRACT

Choosing between alternative spellings for sounds can be difficult for even experienced spellers. We examined the factors that influence adults' choices in one such case: single- versus double-letter spellings of medial consonants in English. The major systematic influence on the choice between medial singletons and doublets has been thought to be phonological context: whether the preceding vowel is phonologically long or short. With phonological context equated, we found influences of graphotactic context—both the number of letters in the spelling of the vowel and the spelling sequence following the medial consonant—in adults' spelling of nonwords and in the English vocabulary itself. Existing models of the spelling process do not include a mechanism by which the letters that are selected for one phoneme can influence the choice of spellings for another phoneme and thus require modification in order to explain the present results.

Introduction

Spelling is an important skill. Writers who are good spellers can concentrate on expressing their ideas rather than on spelling the individual words, and their readers will not be hurt by misspellings. Although spell checkers are of some help, they miss errors that form words, such as ‹canon› for ‹cannon› and ‹trail› for ‹trial›. Knowledge of spelling is important for reading as well as for writing. Good spellers possess the precise representations of words that are thought to be important for accurate word identification, and they can devote more attention to higher levels of text comprehension (e.g., Hersch & Andrews, 2012).

Despite the importance of spelling, fewer studies have examined the processes that are involved in spelling than the processes that are involved in reading. The present study focused on one aspect of spelling that can be difficult even for adults: choosing between alternative spellings of a phoneme. Many phonemes in English and other languages have more than one possible spelling. For example, a number of English consonants may be spelled with either single letters or doublets. Educated adults sometimes make mistakes involving doubling (Holmes & Ng, 1983; Pollock & Zamora, 1983; Wing & Baddeley, 1980; Yannakoudakis & Fawthrop, 1983), although good spellers make fewer such mistakes than less good spellers (Holmes & Ng, 1983). What knowledge do adults possess that allows them, at least most of the time, to make the correct choice? Spelling can involve the spelling of real words or the spelling of novel items, which are potential words. Here we focused on the latter, examining adults' use of singleton versus doublet spellings of medial consonants in a nonword production task.

Previous studies suggest that the phonological properties of the preceding vowel influence people's decisions about whether to spell a medial consonant with a singleton or a doublet. Evidence for the importance of phonology comes from a study in which English speakers heard a series of disyllabic nonwords with single medial consonants and, for each one, were asked to choose between a spelling that included a medial consonant singleton and an

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otherwise identical spelling that included a doublet (Cassar & Treiman, 1997). If the vowel in the first syllable was one of those traditionally called *short* (/æ/, /ɛ/, /ɪ/, /ɑ/, /ʌ/, or /ʊ/ for American English, what phonologists call *lax* vowels), adults and older children favored spellings with consonant doublets. For example, they tended to choose ‹zimmen› over ‹zimen› as a spelling of /ˈzɪmən/. If the first syllable of the spoken nonword contained a *long* vowel or *diphthong* (what phonologists call *tense* vowels), adults and older children strongly preferred single-consonant spellings. Davis (cited in Nunes & Bryant, 2009), working with children of around 8 years old and above in a task in which participants produced spellings of nonwords, found more use of consonant doublets after short vowels than after long vowels. Deacon, Leblanc, and Sabourin (2011) reported a similar result in a spelling production task involving real words. These findings suggest that the phonological context in which a medial consonant occurs influences people's decisions about whether to spell that consonant with a singleton or a doublet. Indeed, many bisyllabic English words with short vowels in the first syllable are written with medial doublets (e.g., ‹happen›), whereas words with long vowels typically have singletons (e.g., ‹open›).

The idea that people use phonological knowledge to make decisions about consonant doubling fits well with *dual-route* models of the spelling process. According to these models, spellers possess a system of rules that relate phonemes to letters—a *phonological* route—as well as a set of stored whole-word spellings—a *lexical* route (e.g., Barry & Seymour, 1988; Houghton & Zorzi, 2003; Kreiner, 1992; Kreiner & Gough, 1990; Tainturier & Rapp, 2001). People use the phonological route when spelling nonwords and words whose spellings are not firmly stored in memory. The experimental findings just reviewed (Cassar & Treiman, 1997; Davis, cited in Deacon et al., 2011; Nunes & Bryant, 2009) suggest that the phonological route includes a rule specifying that a single medial consonant phoneme that follows a stressed vowel and that precedes an unstressed vowel is spelled with a doublet if the preceding vowel is phonologically short and with a singleton if the preceding vowel is long or diphthongized. Although use of this *phonological doubling rule* leads to correct spellings of many words, it causes errors on *exception words* such as ‹canon›, ‹manic›, and ‹leopard›. According to the dual-route view, the lexical route is required to spell such words correctly. In line with these ideas, some educators have suggested that children should be explicitly taught the phonological doubling rule and should individually memorize the spellings of words that do not conform to it (e.g., Carreker, 2005; Scientific Spelling., 1992).

The present study asked whether the choice between singleton and doublet consonants is largely a matter of phonology, as typically assumed, or whether it is influenced by *graphotactic* context. Graphotactics refers to patterns involving the order and arrangement of letters, patterns that relate to spelling alone and not to pronunciation. We hypothesized that graphotactic context would influence the choice between singletons and doublets, and we tested this hypothesis in two experiments in which we asked adults to spell disyllabic nonwords with short stressed vowels in the first syllable. This context specifies doubling of medial consonants according to the phonological doubling rule. If graphotactic context is influential, however, participants might use doublets at low rates before or after certain letter sequences.

The idea that contextual effects on the choice among alternative spellings are in some cases better understood as graphotactic than as phonological is supported by a recent study in which adults spelled monosyllabic nonwords such as /hɪf/ and /flok/ (Treiman & Kessler, 2016; see Hayes, Treiman, & Kessler, 2006, for a similar study with children). Participants tended to avoid final sequences such as ‹ff› and ‹ck› if they spelled the preceding vowel with two or more letters, although they did often use these sequences if they spelled the preceding vowel with one letter. Participants' spelling choices for the final consonants were better explained by the number of letters that they used to spell the preceding vowel—graphotactic context—than by whether that vowel was long or short—phonological context. These results are problematic for dual-route models of the spelling process as currently instantiated. This is because the phonological route of these models translates from phonemes to letters and does not include a mechanism by which the spelling that participants select for one phoneme can influence the spelling that they select for another. Indeed, the best developed computational model of the spelling process to date, the dual-route model of Houghton and Zorzi (2003), could not account for the effects of graphotactic context that were observed in the Treiman and Kessler experiment.

In the present study, we asked whether effects of graphotactic context on spelling are limited to the types of monosyllables studied by Treiman and Kessler (2016) and Hayes et al. (2006) or whether they are more widespread. This issue is important not only because of its implications for specific models of the spelling process but also because of its relevance to the broader question of whether writing is purely a reflection of speech or whether it is a system with its own patterns and properties. If the former view (e.g., Frost, 1998) is correct, then the production and interpretation of written language must depend largely on phonology. If the latter view (e.g., Berg, 2016b) is correct, then one must look beyond phonology to understand writing systems themselves and how people learn and use them.

Medial consonant doubling is a good test case for the study of graphotactic context, not only preceding context, as studied by Treiman and Kessler (2016) and Hayes et al. (2006), but also following context—the letters yet to be written. This is because, according to several linguistic studies, there are some graphotactic patterns in the English writing system that might influence spellers' doubling of medial consonants. These include a tendency for consonants not to double after vowel spellings of more than one letter and a tendency for doubling to be less common before ‹ic›, ‹id›, and ‹it› than before many other letter sequences (e.g., Berg, 2016a; Carney, 1994; Rollings, 2004). These patterns are graphotactic in that they reflect the spellings of the preceding and following elements rather than their pronunciations. For example, doubling seems to be less common after /ɛ/ when it is spelled as ‹eo›