The cultural evolution of informative writing systems

Jon W. Carr[*1] and Kathleen Rastle[1]

[*]Corresponding Author: jon.carr@rhul.ac.uk
[1]Department of Psychology, Royal Holloway, University of London, England

The written and spoken forms of a language are subject to different evolutionary pressures. Over time, this can result in substantial divergence between the two, as each form of the language becomes better adapted to its own niche (Rastle, 2019). One example of this is the heterographic spelling of homophonous words, such as *knight* and *night*. Written wordforms such as these impose additional costs in learning but may be beneficial in reading because they reduce ambiguity. If the benefit in reading outweighs the cost in learning, heterography may be selected for in the evolution of writing systems. We investigate this possibility by experimentally simulating the evolution of orthographic systems using the iterated learning paradigm (Kirby, Tamariz, Cornish, & Smith, 2015), contrasting what happens in the presence and absence of communicative pressure for ambiguity avoidance.

We consider two possible mechanisms by which heterography might emerge (Berg & Aronoff, 2021). In Experiment 1, we consider *differentiation*, which involves the creation of new spellings or the repurposing of existing spellings to differentiate words that are homophonous in speech. For example, the words *plain* and *plane* were originally variant spellings of the same word, but they have taken on distinct meanings over time (Carney, 1994, p. 412). In Experiment 2, we consider the *conservation* mechanism, in which heterographic homophones arise as an epiphenomenon of sound change. For example, the words *meat* and *meet* are homophonous in modern English due to the /ɛː/–/eː/ merger that took place during the Great Vowel Shift, but their spellings are heterographic because they continue to reflect Middle English pronunciation (Wells, 1982, p. 140).

We created a simple 3×3 stimulus space of colored shapes. The words for these stimuli consisted of a stem and a suffix, and participants were taught both the spelling and pronunciation. The stems—*buvi-*, *zeti-*, and *wopi-*, which represent shape—never changed over time, but the suffixes (explained below) *could* change. Participants were arranged in transmission chains, with each participant learning the orthographic output of the previous participant in the chain. We ran ten chains of nine generations in each of two conditions: Transmission-only, in which participants were simply tested on the orthographic system they had been trained on, and Transmission + Communication, in which each generation consisted of a pair

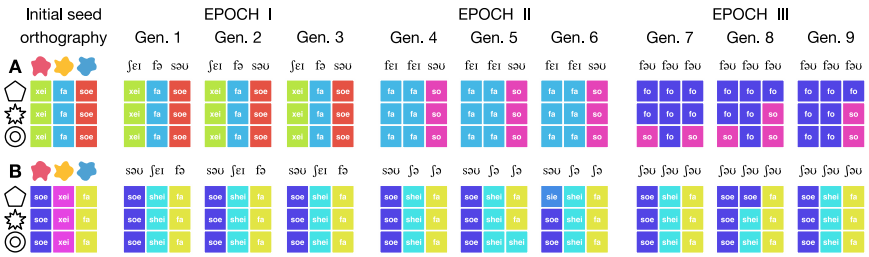

Figure 1. Suffix spellings in two example chains from Experiment 2. Each color represents a unique suffix spelling. **A** Transmission-only condition. The orthography transparently reflects the increasing homophony but, as a result, becomes unable to express the color dimension. **B** Transmission + Communication condition. The orthography is conserved in the face of increasing homophony, allowing the system to express color at the expense of transparency.

of participants who played a communication game that incentivized ambiguity minimization (following similar methods to Kirby et al., 2015).

In Experiment 1, which tests the differentiation mechanism, the suffixes were always pronounced /-kəʊ/, but the orthography was seeded with high variation, such that the suffix could be spelled in many different ways using the graphemes ⟨c⟩, ⟨k⟩, ⟨q⟩, ⟨o⟩, ⟨oe⟩, and ⟨oh⟩. We hypothesized that, under communicative pressure, the orthographies would be more likely to adopt differentiated suffix spellings conditioned on color (e.g., ⟨-co⟩, ⟨-koh⟩, and ⟨-qoe⟩ for pink, yellow, and blue), despite all colors being expressed homophonously in speech (i.e., /-kəʊ/). However, the results revealed little evidence of differentiation. In most cases, the orthographic systems simply became transparent—a single spelling was adopted for the suffix regardless of color, even under communicative pressure.

In Experiment 2, which tests the conservation mechanism, the initial seed systems were entirely regular and compositional, with distinct suffixes for each color (e.g., /-səʊ/, /-fə/, and /-ʃɛɪ/ spelled ⟨-soe⟩, ⟨-fa⟩, and ⟨-xei⟩). Over three epochs, we experimentally induced sound changes that resulted in increasing homophony. We hypothesized that, under communicative pressure, the orthography would be more likely to remain intact, continuing to express color at the cost of transparently mirroring the homophony. Indeed, this is what we observed across several chains; an example is shown in Fig. 1.

Our findings suggest firstly that pressure for informativeness (induced through communicative pressure) can give rise to spellings that are more expressive than their spoken counterparts, and secondly that informative heterography is easier to attain through the conservation (as opposed to differentiation) mechanism. We further discuss how these small-scale simulations can inform our understanding of the real-world processes underlying spelling change, including the roles of variation, redundancy, top-down reform, and other functional explanations.

Acknowledgments

This work was funded by a Leverhulme Trust Research Project Grant (grant number: RPG-2020-034).

References

Berg, K., & Aronoff, M. (2021). Is the English writing system phonographic or lexical/morphological? A new look at the spelling of stems. *Morphology*, *31*(3), 315–328.

Carney, E. (1994). *A survey of English spelling.* Routledge.

Kirby, S., Tamariz, M., Cornish, H., & Smith, K. (2015). Compression and communication in the cultural evolution of linguistic structure. *Cognition*, *141*, 87–102.

Rastle, K. (2019). EPS mid-career prize lecture 2017: Writing systems, reading, and language. *Quarterly Journal of Experimental Psychology*, *72*(4), 677–692.

Wells, J. C. (1982). *Accents of English* (Vol. 1). Cambridge University Press.