

# The Rhythm of Handwriting

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*In response to “Handmade” (Vol. 3, No. 3).*

*To the editors:*

In his review of our paper, Vivian Cook asks whether conclusions based on the writing of one language, Italian, can be generalized to other languages. In our study, we showed that the handwriting of Italian children, starting in the first grade of primary school, follows two rhythmic principles—*isochrony* and *homothety*. We concluded that handwriting depends on “general constraints on the timing planning of the movement,” with no room for language variation. The term *rhythmic structure* is central to this proposal and is the focus of Cook’s review.

As Cook notes, the rhythm of oral languages varies. Although there is a debate as to how to characterize this variation,<sup>1</sup> for our purposes, it is enough to assume that languages can be roughly characterized as *syllable-timed* or *stress-timed*. This depends on whether *isochrony* is given by the syllable,<sup>2</sup> which have all roughly the same duration, or only by stressed syllables, whereby the intervals between two stressed syllables have the same duration. These differences are grounded in the properties of phonological systems associated with particular languages. We argue that these differences have no impact on handwriting. In order to explain our position, we first need to clarify the meaning of the terms used, which can vary depending on the scientific context. In spoken languages, *isochrony* should refer to a sequence of equal intervals—in music this is called the *reference tempo*. In handwriting, *isochrony* is the tendency to keep the duration of the whole writing movement constant across geometric scaling. The other principle that governs handwriting is *homothety*, which is concerned with the timing of sub-components. The relative durations of the individual letters that compose a word remain constant across changes in the duration of the whole word. *isochrony* and *homothety* are two principles that govern the rhythm of writing, as well as other body movements.<sup>3</sup>

Why, as Cook implies, should handwriting *isochrony* or *homothety* be influenced by the phonology of a given language? This is an empirical question, but we believe that neither *isochrony* nor *homothety* are influenced by particular phonological systems. The symbols used in writing are highly abstract entities entirely separate from the sound system of a given language as far as the movement for their realization is concerned. These abstract entities encode the variabilities of the graphemes, the graphs of phonemes and phones. The grapheme <c> has the same shape and size regardless of whether it appears in the word ‘cat’ or in the Italian word ‘cane’ (dog). <c> corresponds to the phoneme /k/, which may be realized differently in the two languages and across different speakers. It has also the same shape and size if it appears in the word ‘chess’ and together with the grapheme <h> corresponds to the phoneme /tʃ/. The same can be said of

homothety: “handwriting is governed by general kinematic laws of human movement and two of them - Homothety and Isochrony - specifically rule the organization in time of its events.”<sup>4</sup>

Does the sound system of a particular language shape handwriting movements? Or is it more parsimonious to conjecture that writing systems evolved by adapting to our biological system, as suggested by Stanislas Dehaene’s neural recycling hypothesis?<sup>5</sup> We chose the second option, which is congruent with the claim that isochrony “might be an inherent aspect of motor planning during handwriting,” and that it “does not depend on practice time nor requires years of practice in order to be implemented.” Homothety is also at work from the first grade of primary school.

Whether these principles are innate is an open question. Children do not need a lot of practice to comply with them, as opposed to other aspects of handwriting—e.g., automatization, fluency—that require time and practice to learn. These findings imply that children can avail themselves of an abstract rhythmic representation of the word before starting to write the word itself. In spite of the fact that handwriting is a cultural invention, it is governed by principles that apply to the temporal organization of movements. In an earlier paper, Pagliarini et al. established that children with developmental dyslexia do not obey isochrony and homothety as well their peers and that their ability to comply with isochrony is correlated with the speed at which they read.<sup>6</sup> This finding favors the hypothesis that reading and handwriting are mediated by rhythm. But this does not necessarily imply that the rhythm of spoken language and that of handwriting are the same, or that the former influences the latter.

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1. See Amalia Arvaniti, “,” *Phonetica* 66, no. 108 (2009), 46–63, doi:10.1159/000208930; Laurence White, Sven Mattys, and Lukas Wiget, “,” *Journal of Memory and Language* 66, no. 4 (2012), 665–79, doi:10.1016/j.jml.2011.12.010.
  2. See, among others, Richard Dasher and Dwight Bolinger, “,” *Journal of the International Phonetic Association* 12, no. 2 (1982): 58–71; Marina Nespor, “On the Rhythm Parameter in Phonology,” in *Logical Issues in Language Acquisition*, ed. I. M. Roca (Dordrecht: Foris, 1990).
  3. Such as drawing, weight-lifting, manual pointing, voluntary contractions of human arm muscles, hand to target-object movement, typing, gait, and wrist movements for handwriting. See the references in Elena Pagliarini et al., “,” *Nature Scientific Reports* 7, no. 5,516 (2017), doi:10.1038/s41598-017-05105-6.

4. Elena Pagliarini et al., “;” *Nature Scientific Reports* 7, no. 5,516 (2017), doi:10.1038/s41598-017-05105-6.
5. Stanislas Dehaene, *Reading in the Brain: The New Science of How We Read* (New York: Penguin Books, 2009).
6. Elena Pagliarini et al., “;” *Human Movement Science* 42 (2015): 161–182, doi:10.1016/j.humov.2015.04.012.

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## More letters for this article

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by Goro Murahata