A Computational Model of the Invention of Writing

How a New Technology Evolved without a Change of Medium or Institutional Context

Richard Sproat

How did writing evolve from a prior *non-linguistic* symbol system?

Two points are generally accepted. First, at least in Mesopotamia, writing was anchored in the institution of accounting: Symbols for commodities evolved into what eventually became the first linguistic script [3, 6, 9, 11]. The medium – incised symbols in clay – did not change. And it was centuries before writing fully escaped its accounting origin and was used for running prose [11]. Second, the key discovery was the *rebus principle* by which symbols could be used not for what they *meant* but how they sounded [1, 2, 4, 10].

But there is a critical component missing in these accounts: *What happened in the brains of the earliest scribes that enabled the transition from a system that represented meaning but was largely unconnected to language, to a system that also encoded **phonology** and was thus **intimately** connected to language?* While humans evolved to speak, they did not evolve to read, and the facility for reading is only possible by co-opting cortical regions originally evolved for other purposes [5]. The connection of the parts of the visual cortex that seem to be involved in the low-level processing of graphemes, to other cortical regions that deal with language – especially phonology, is something that must be learned by fluent readers, and presumably developed for the first time with the earliest writing.

The neurological underpinnings of the evolution of writing have received scant attention. One exception is Overmann [8], who casts her approach in terms of *Material Engagement Theory* [7]. Overmann suggests that repeated motor movements of the hand in writing symbols, along with the visual "reading" of (pre-linguistic) texts in an administrative context reorganized the brains of scribes, thus enhancing the connection between symbols and language. But, while the repeated writing and "reading" of symbols was surely important, *and was presumably critical in fixing the association between symbol and meaning*, it is not clear why such actions would specifically train the association between the visual cortex and the cortical regions that deal with *phonology*. With that point in mind, I offer a more specific hypothesis:

> Writing evolved in an *institutional* context in which symbols were *dictated*, so that the user of the symbols gradually came to associate them with sounds.

Imagine an ancient accounting house. An overseer is "dictating" accounts: "25 sheep, 30 goats, ...". Each of these concepts has an associated accounting symbol, so the tie between symbol and *meaning* is already there. By constant oral repetition and the subsequent transfer of the messages to sequences of graphical symbols, new associations to phonology were formed. *Thus the connection was built to language more generally, insofar as the symbols became associated with both **sound** and **meaning**.*

In support of this hypothesis, I present a Deep Learning simulation. By constant repetition of accounting "texts" and their associated linguistic forms, the model learns to associate symbols with sounds, and is able to extend these symbol-sound associations to write words which previously did not have a written representation.

Select Bibliography

Boltz, William. 2000. Monosyllabicity and the origin of the Chinese script. Technical Report 143, Max-Planck- Institut für Wissenschaftsgeschichte, Berlin.

Coulmas, Florian. 1989. *Writing Systems of the World*. Oxford: Blackwell.

Damerow, Peter; Robert Englund and Hans Nissen. February 1988. Die Entstehung der Schrift. *Spektrum der Wissenschaft*, pages 74–85.

Daniels, Peter. 1992. The syllabic origin of writing and the segmental origin of the alphabet. In Downing, Pamela; Susan Lima and Michael Noonan, editors, *The Linguistics of Literacy*, number 21 in Typological Studies in Language, pages 83–110. Amsterdam and Philadelphia: John Benjamins.

Dehaene, Stanislas. 2009. *Reading in the Brain: The Science and Evolution of a Human Invention.* New York: Viking.

Englund, Robert. 2011. Accounting in Proto-Cuneiform. In Radner, Karen and Eleanor Robson, editors, *Oxford Handbook of Cuneiform Culture*, chapter 2, pages 32–50. Oxford: Oxford University Press.

Malafouris, Lambros. 2013. *How Things Shape the Mind: A Theory of Material Engagement.* Cambridge, MA: MIT Press.

Overmann, Karenleigh. 2016. Beyond writing: The development of literacy in the Ancient Near East. *Cambridge Archaeological Journal*, 26 (2).285–303.

Schmandt-Besserat, Denise. 1996. *How Writing Came About.* Austin, TX: University of Texas Press.

Steinthal, Heymann. 1852. *Die Entwicklung der Schrift, nebst einem offenen Sendschreiben an Herrn Professor Pott.* Berlin: Ferd. Dümmler's Verlagsbuchhandlung.

Woods, Christopher; Emily Teeter and Geoff Emberling, editors. 2010. *Visible Language: Inventions of Writing in the Ancient Middle East and Beyond.* Number 32 in Oriental Institute Museum Publications, Chicago: Oriental Institute.