All forms of writing: A neuroanthropological commentary on *Reading in the Brain* (Dehaene, 2009).

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Abstract: Anthropological contributions are essential to understanding the evolution of writing and its potential variation. Although Stanislas Dehaene calls for a "neuro-anthropological perspective," he neglects anthropological evidence, including the only indisputable case of independent invention of writing: the pre-Columbian systems of the Americas. Here I suggest that anthropological and historical accounts of the cultural evolution of language suggest that ecological, technological, social and political factors have influenced the ongoing development of writing systems, even in directions contrary to that predicted by a model of increased neural efficiency. In addition, Pre-Columbian writing systems, not subject to a diffusionist confound because of their independence, caution that our research on diversity in writing may represent a small, systematically biased sample. To truly understand neuro-cognitive variation, we have to avoid both overly ambitious universalisms and radical cultural relativism.

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Introduction

The estrangement of anthropology from cognitive science has made it more difficult to take account of human diversity and cultural evolution in cognition. In isolation, many brain scientists mistakenly regard social sciences as uniformly characterized by the most radical forms of cultural constructionism and treat acknowledgement of cultural variation as tantamount to renouncing biology or even scientific explanation. The problem for cognitive research is that anthropologists offer the most detailed analyses of the archaeological record and

extant cultural diversity.

This cross-disciplinary stalemate has grown especially frustrating in recent decades with a greater emphasis on human variation, including embodied approaches to cognition, increased interest in comparative research, and a growing desire to ground cognitive theory in evolutionary theory. The rise of cultural neuroscience and increased empirical evidence of inter-group psychological variation have led many scholars to call for a renewed conversation between these two areas: sciences of cognition and of culture (Beller, Bender and Medin 2012; Bender, Hutchins and Medin 2010; Lende and Downey 2012). The good news is that a renaissance of biocultural research in anthropology, approaches that combine cultural and biological perspectives, makes cooperation more likely.

Stanislaus Dehaene's *Reading in the Brain* offers a timely example of how the hardened divide between cultural and cognitive theory can undermine an otherwise admirable work. Dehaene's book is a remarkable achievement; the work is to be applauded both stylistically and in terms of its depth. *Reading in the Brain* is an exemplary popular account of cognitive research, showing that an engaging work can include sophisticated, even innovative theoretical material. However, the over-arching rhetorical framing of Dehaene's book, particularly spurious attacks on social science and adamant assertions of universalism in the face of his own evidence of variation, unnecessarily casts the work into an obsolete debate (see also Bolger et al., 2005; Coltheart, this issue).

Dehaene identifies social sciences, a notoriously divided and theoretically heterogeneous collection of fields, with a single extreme, ideologically-motivated form of cultural determinism:

> Only our species is capable of cultural inventions as sophisticated as

> reading—a unique feat, unmatched by any other primate. *In total opposition to the standard social science model, where culture gets a free ride on a blank-slate brain, reading demonstrates how culture and brain organization are inextricably linked.* (2009: 9, emphasis added)

Although the sweeping mischaracterization would be an irritant by itself, the greater problem is that the outdated polemic discourages Dehaene from seriously considering evidence of profound cultural diversity in writing systems and from employing co-evolutionary accounts of culture-biology relations from anthropology, accounts that fit his data much better than those offered by the evolutionary psychology that he cites (e.g., pp. 306-308). In spite of the many strengths of Dehaene's book, these gaps demonstrate two key areas — cultural diversity and evolutionary theory — where anthropological insight is missing.

This article is divided into two parts: the first briefly reviews examples of how ecological, technological and social-political factors have influenced the development of writing systems, suggesting that a strictly neurological account of cultural evolution is inconsistent with the best available evidence from existing writing systems. No doubt, neural constraints play a key role in cultural evolution, but writing systems also have been affected historically by ecological, technological, social and political forces; an account of cultural evolution must be multidimensional as it is a complex emerging systems. Multidimensional models, like gene-culture co-evolutionary theory, provide a way of capturing these interactions (see also Menary, this issue).

The second part of this essay briefly discusses pre-Columbian writing systems. Dehaene's account of neurological constraint runs up against the problem of a "diffusionist confound": all contemporary writing systems are linked through

diffusion (cultural spread) and mutual influence. The only certain, *truly* independent invention of writing — pre-Columbian American orthographies — strain our definition of "writing" and challenge virtually any claim of universals in writing system.[1]

Neither of these issues are fatal to Dehaene's central thesis, the proposal of "neural recycling," I would emphasize. On the contrary, I think Dehaene's research, including the evidence of neurological limits upon cultural variation, is precisely the sort of case study that can force new fields like cultural neuroscience and neuroanthropology to move beyond an obsolete assumption that cultural and biological explanation of cognition must necessarily be at odds.

Cultural evolution of writing

One place where Dehaene's adherence to an anti-social sciences rhetorical framework is especially awkward is his neurologically-driven account of the cultural evolution of writing systems (esp. Chapter Four, pp. 171-193). Dehaene suggests that "cultural relativism" necessitates that scholars treat "cultural variations" as "essentially unlimited" (p. 174),[2] but the greater problem is his causal account of cultural change, which suggests that neurological efficiency is the predominant force. Here, a strong argument that "writing evolved to fit the cortex" (p. 171) runs headlong into the much more varied historical trajectories of various writing systems that the book discusses.

Dehaene lays out the strong form of his neurological determinism:

> If our brain organization places a drastic limit on cultural variations, some striking cross-cultural regularities should be apparent in all past and present writing systems. These regularities should ultimately be traced back to

> cerebral constraints. (P. 173).

The question is not whether our "genetic makeup" places *any* limit on possible writing systems; the question is *how* severe this limit is, and whether neural constraints are determining the evolution of writing systems, evident in drift toward a uniform, neutrally most-efficient character. Dehaene is elsewhere adamant:

> Overall, the analysis of writing systems underlines the fact that letter shape is not an arbitrary cultural choice. The brain constrains the design of an efficient writing system so severely that there is little room for cultural relativism. Our primate brain only accepts a limited set of written shapes. (P. 179)

If the strong form of Dehaene's argument is to hold up, he must demonstrate, not just cross-cultural regularities (themselves problematic), but also that any regularities derive from "cerebral" constraints. His own work and that of the research he cites, however, suggests the crucial influence of ecological, technological, sociological, and even political factors in determining the evolution of writing systems.

Ecological contributions

Dehaene (2009: 176-178) cites the work of Marc Changizi and colleagues (2006) on the visual elements of writing systems: all share basic visual forms, especially that characters are composed of around three or less strokes, that is, curves or lines that can be traced without lifting a stylus or pen.[3] Dehaene argues that, "In all writing systems, the world over, characters appear to have evolved to an almost optimal combination that can easily be grasped by a single neuron, through the convergence of inputs from two, three, or four types of curve-detecting neurons at a level immediately preceding it in the [cortical] pyramid" (2009: 177).

Dehaene interprets Changizi's research as supporting his neural constraint account of language evolution.

Changizi and colleagues, in fact, propose that the configuration of characters closely correlates with the appearance of shapes in naturally occurring visual scenes. They argue that the configuration of diverse writing systems is co-determined by both ecological patterns and neurological constraints (Changizi and Shimojo 2005; Changizi et al. 2006). Writing is shaped by neurology because the human nervous system has already been tuned by an evolutionary relationship with salient stimuli in the natural environment. According to Changizi, their argument could more accurately be described as "nature-harnessing" rather than neural-determined; written characters mimic the most common visual qualities of natural objects (personal communication).

This "nature-harnessing" approach is consistent with a deeper recognition of exaptation in evolution; "exaptation" is a term suggested by Gould and Vrba (1982) to acknowledge that most traits of living organisms are re-adaptations of structures that arose and were shaped by multiple iterations of adaptation over evolutionary time. The brain systems "recycled" to perceive writing were already "recycled" to support the manufacturing of tools, the tracking of prey on the forest floor and capturing of small prey in the forest canopy, the picking of fruit and flowers, the avoidance of predators, and so on, back to the development of the first light-sensitive cells in ancient ancestors. Our understanding of neural "recycling" should not artificially truncate a long history of exaptation in which gene-environment causal relations have been reiterated through countless adaptive loops.

Technological influences

The material qualities of writing also influence how characters are

perceived. Handwritten scripts elicit a different set of neurological resources than typeset fonts, as Nakamura and colleagues — including Dehaene — have shown (Nakamura et al. 2012; see also Perfetti and Tan 2013). Cursive primes, but not typographic primes, act on the left dorsal premotor cortex (PMd), or Exner's area. The finding suggests that the meaning of cursive writing was inferred in part from the gestures that would have produced it. As Nakamura et al. write, "the VWFA [visual word form area] mediates fluent recognition of letter strings and does so with high efficiency *primarily for typographically well-formed words with proper spacing*" (2012: 20766, emphasis added). In contrast, the PMd "contributes to fluent reading by inferring the writing gestures corresponding to the observed handwritten letters," although this might vary for left-handed individuals (ibid.).

Although Nakamura, Dehaene and colleagues conclude that this finding demonstrates that the neurological reading system is more "universal" than "previously thought," one could just as easily conclude that the neural reading system is sensitive to technological influences. Prior to the advent of moveable type and the ensuing social changes in who could read — illiteracy rates were likely around 99% before the printing press — the "universal" neural underpinning of reading would have much more prominently featured this motor-based system taking in the left PMd.

Cursive systems balance the neural and physiological demands of both reading *and* writing; our current neurological systems for reading, thus, are influenced by the technological supports we have for producing uniform, typeset texts, making manual writing much less of a constraint on our orthography. Changizi and Shimojo (2005: 272) discuss this technological shift:

> Writing systems are under selective pressure to be easy to read and write,

> but there are reasons to think that the principal pressure is for ease of reading…. Many writing systems throughout history, however, were not read to the extent that contemporary writing systems are... Second, cursive scripts and shorthand are two classes of writing system where selection is primarily driven by writing optimization, and in these cases the characters are qualitatively very different compared with those of the typical writing system, and are more difficult to read. Third, and last, typeface and computer fonts are two classes of script where there is no selective pressure for writing at all, and characters in these scripts are qualitatively quite similar to those of the typical writing system.

The current dominance among readers of English of the left hemisphere occipitotemporal visual system — what Nakamura and colleagues (2012) refer to as "reading by eye" — over a premotor-based system that recognizes letters by gesture, is thus partially a technological achievement peculiar to late twentieth-century English. Not all writing systems have made an identical transition into vision-determined orthographies in standardized typefaces. For example, Arabic and many writing systems of South Asia (e.g. Bengali, Devanagari and Oriya) are more script-like when printed, with long, complex strokes, and continuous lines between some characters. The gesture-based system was first discerned in close studies of readers of Chinese characters, who disproportionately use gesturally-influenced neural processing streams to decode their writing system, even when printed (see Bolger et al. 2005; Tan et al. 2005).[4]

The technological contribution to the evolution of reading is likely not finished. The increased use of keyboards to write, the growth of computer-mediated "texting," and the disappearance of cursive writing from many people's daily lives

will influence how we learn to read. These technologies are likely to *increase* the dominance of the visual neural contributions to reading, causing even greater atrophy of a gestural-based reading system, especially with changes in primary education incorporating keyboard-based pedagogy.

At the same time, computer-mediated communication (CMC) is exerting its own influence on the way that English is written by adults, driving an increased use of abbreviations, nonstandard spellings (including irregular contractions), homophones ("gr8" and "u"), and "emoticons" (symbols representing emotions, such as ";^)"). Other features of writing are neglected in texting, including vowels, capitalization, punctuation, and unnecessary words (see Drouin and Driver 2012). As researchers have found, the constraints of CMC technologies, such as the 160-character limit in short message services (SMS), are driving condensation and orthographic innovation (see Shafie et al. 2011). The outbreak of CMC-related innovation is striking, especially as the innovations are compounding rapidly; witness, for example, the blindingly fast emergence of the acronym "LOL" ("laugh out loud") as a mode to communicate non-verbal information, and its re-entry into spoken communication, transformed in some cases into a noun, "lulz."

Because I work with some blind activists, I'm particularly interested in the rise of audio books and automated text-to-speech conversion. Like the rise of CMC, text-to-speech technology might shift the way that many people produce and process texts, with unpredictable long-term effects on the neurological substrates of "reading."[5] Expert text-to-voice readers are able to accelerate the artificial voice with practice to more than 300 words-per-minute; normal audio books are 120 to 140 words-per-minute. To a listener unfamiliar with the technology, the resulting audio text sounds like gibberish. In other words, technological change is likely to

continue to affect the neural underpinnings of reading, perhaps even taking forms that current researchers would not designate "reading," just as prior technologies such as the printing press influenced human neural systems became skilled.

Social and political determination

Dehaene (2009: 186, figure 4.3) argues that "convention and simplification are two essential factors in the evolution of writing." Both of these traits, however, are as much social, pedagogical, and practical as they are neurological. Without convention, for example, writing cannot act as communication; the shared social quality of writing exercises the strongest conventionalising force. A private written language, such as automatic writing or psychography (supernaturally inspired "spirit writing," interpreted by a medium), need follow no convention.

In addition, simplification is generally a political project, not just a neurological tendency. The recalcitrant complexity of English spelling, the opacity of its orthography, an example Dehaene repeatedly discusses, shows that neural efficiency can be counter-acted by social conservatism, including the prestige of traditional forms of writing. Social groups can invest heavily in preserving complexity, even increasing it, in order to cement their standing. Dehaene (2009:188) offers the cases of Egyptians and Sumerians who "came very close to the alphabetic principle, but neither managed to extract this gem from the overblown writing systems." In fact, both groups loaded greater complexity into their orthography in order to resolve ambiguities because writing was the preserve of a social caste with a vested interest in securing exalted status by mastering an opaque system.

With sufficiently strong political motivation, however, change can occur

quickly. Written Turkish changed radically in 1928 when its writing system based on Arabic was replaced abruptly by a smaller set of Roman-derived characters under nationalist President Kemal Atatürk; reform of the writing system was part of a broader modernization project. In 2009, Brazil reformed written Portuguese, including abolishing silent letters, simplifying accents, and officially including three new letters ("k", "w" and "y"). If these reforms succeed, they will confirm a shift in cultural influence within the Lusophone or Portuguese-speaking world, with Brazil in ascendance, and due to foreign influences (all three letters were widespread in loan words).

Many efforts toward simplification have historically been driven by colonialist, nationalist and populist projects; orthographic reform often has been linked to projects of mass literacy, such as the promotion of *pinyin* in China under Mao Zedong, or multiple waves of orthographic reform to Russian, first under Peter the Great and, later, the early Soviet regime. During the Russian revolution, the Baltic fleet sailors legendarily removed newly obsolete characters from the printing plants of Petrograd, stirred by a vision of mass literacy for social progress. In Azerbaijan, changing political fortunes in the twentieth century led to multiple reforms to Azerbaijani writing, from an Arabic-based script to a Latin one, then to a Cyrillic-based orthography under Soviet control. Abolishing the Cyrillic-derived system and returning to a Roman alphabet was one of the first acts of the newly-independent Azerbaijan Parliament (see Hatcher 2008). One could cite countless examples of politically-motivated orthographic simplification: the purging of Dutch spellings from Bahasa Indonesia in the 1970s, Noah Webster's reforms to American English, the simplification of spelling as part of nation building in France and Germany. To understand the evolution of writing systems, one need take account

of political events as much as the configuration of the brain regions adapted to reading.

A more complex model of cultural evolution

In summary, we have to add environmental, technological, social and historical factors to the neural constraints that Dehaene (2009:189) cites for shaping writing systems. To account for the neuro-cultural emergence of mass literacy in the West with its own peculiar history, for example, we would have to consider theological upheaval, changing class structure, the invention of moveable type, pedagogical innovations, and the democratization of primary education, but we must also recognize how recalcitrantly conservative writing systems can be.

This complexity is consistent with Dehaene's own account of multiple cases of orthographic change (see esp. 184-193); I suspect he could offer even more examples of these types of processes. However, fully integrating causal complexity would be much easier if Dehaene were able to draw on co-evolutionary theory in anthropology, in which theorists recognize the interaction of socially-transmitted information or behavior with the underlying genetic endowment of a species, given sufficient time (see, for examples, Downey and Lende, 2012; Durham, 1991; Lumsden and Wilson, 1981; Menary, this issue). Although the metaphor of writing as a "virus" (p. 190) or the account of the Greeks perfecting the alphabet are evocative, they do not capture the complex relations between biology and culture that Dehaene elsewhere argues must be part of the account of the human ability to read (e.g., p. 146). Cultural evolution is just as powerfully shaped by political and social history, technology and ecology, as the individual's ability to read is shaped by the interaction of educational techniques with our nervous system.

The diffusionist confound in writing research

Although Dehaene admirably draws on cross-cultural data, his commitment to a strong universal account leads him to neglect some of the most interesting outlier forms of writing. The test of any strong theory of universal neural structures is not a cluster of closely-related phenomena, but how well the model explains the most unusual variants. In the case of writing systems, the problem of outliers is exacerbated by a diffusionist confound that skews our extant sample: all modern writing systems have arisen from shared ancestors and are marked by a complex genealogy of inter-cultural exchange and mutual influence. The potential universal cognitive patterns are difficult to disentangle from the historical fact of common origins, intercultural borrowing, and convergent development, especially since the advent of print and increased global flows of culture. To put it another way, the writing systems Dehaene discusses are not independent experiments, so whether any pattern of uniformity reflects cognitive constraint or historical relations is open to debate.

Writing has only been independently invented, *at most*, four times: in Southwest Asia, the Americas, Northeastern Asia, and possibly Oceania. The case of Rongorongo in the Pacific is especially controversial and difficult to document; Rongorongo iconography is thought by some to have arisen from contact with European colonial powers (Fisher 1997).[6] Some researchers further argue that the invention of Chinese writing was prompted by trade contacts with southwest and south-central Asia. If both East Asian and Pacific writing systems arose through cultural diffusion from southwest Asia and Europe, then the historical entanglements among writing systems complete a whole diffusionist cloth.

If then all Asian, European, and African writing systems are potentially a result

of cultural diffusion and ongoing interaction, the current *variation* in writing systems begs explanation. The question of universality could be turned on its head: how did evident diversity arise from shared origins? If most writing systems are closely related through historical diffusion and subject to severe neurological constraint, how did so many diverse systems — alphabets, syllabaries, abjads, logosyllabaries, abugidas, morphemic scripts — arise (see Daniels 2009)? Walter Mignolo (1989: 62) cautions against a teleological understanding of cultural evolution: "the history of writing is not an evolutionary process driving toward the alphabet, but rather a series of coevolutionary processes in which different writing systems followed their own transformations." We can argue for patterns and biases in these trajectories of transformation without arguing for a universal and inevitable road for cultural evolution.

Pre-Colombian writing: the independent experiment

Given the diffusionist confound in extant writing systems, anthropology brings an especially important case study, the *only* certain case of independent invention: the Pre-Colombian systems of the Americas. Dehaene only discusses these systems in passing. To examine whether writing systems are shaped by invariant neurological traits, the American systems are the truest test, because relations through diffusion can be ruled out confidently.

The earliest forms, such as Olmec and Zapotec, are less well known (or understood) than later Mayan orthography, but all demonstrate marked differences from Old World systems. Boone (1994) argued that most of the American systems are semasiographic, conveying meaning directly without phonetic significance. More recent analyses have increasingly suggested that, in fact, a mixture of ideographic and syllabic orthography is present in Mayan hieroglyphs, the best-

studied and most complex pre-Columbian writing system (see Boone and Mignolo 1994).

Boone (1994: 3) has suggested that we tend to think of writing as "visible speech," but Meso-American systems were more closely aligned with what Western theorists might refer to as "art." If this is accurate, then these systems differ on perhaps the most fundamental trait shared by other forms of "writing": that writing records speech. Some critics might argue, for this reason, that the Meso-American systems are not "writing" *sensu stricto* but some other form of expression (see Daniels 2009; Perfetti 2009). Nevertheless, they were a "graphic system that keeps and conveys knowledge, or, to put it another way, presents ideas" (Boone 1994).

Dehaene (2009: 184) touches on one of the most intriguing characteristics of the American systems briefly, pointing out that they used stylized faces to denote syllables, dates, proper names, or concepts (see Figure 1). Dehaene glosses over this difference, pointing out the great distance in the brain between the "letterbox" area and the region of the cortex generally responsible for face recognition, which sits in the opposite hemisphere: "The near absence of faces among written symbols could be taken as another indirect proof that brain architecture constrained the evolution of writing" (ibid.).

In contrast, Houston, Robertson and Stuart (2000) argue that Classical Mayan glyphs demonstrate consistency across six centuries (about the same time as the West has had the printing press). We simply cannot know if neurological pressures for efficiency would have eventually led to the elimination of face-based epigraphy, nor can we know what sorts of functional neural systems arose in the scribes who could read and write these systems of glyphs. Historically, Spanish colonization and vigorous persecution, not cognitive inefficiency, led to the demise of face-based

epigraphy.

Among the handful of American writing systems, the general pattern of historical development was opposite to what Dehaene (and others before him) suggests: a mixture of faces together with phonetic and abstract symbols in Mayan glyphs became more exclusively faces together with pictorial ideographs in later Mixtec and Aztec writing (Mignolo 1989). Phonetic symbols disappeared. The American systems became *less* alphabet-like, less phonetically-based, and *more* ideographic over centuries of use (see also Boone 1994: 4). In fact, Boone, like other researchers who study Aztec and Mixtec writing, is not even convinced that these later written systems were based on language, but may have been an independent pictorial representation systems akin to mathematical symbols, maps, musical notation, or even corporate logos (1994: 5-6). If so, then the American writing systems shed their direct connections to language over time, in direct opposition to the model of evolution suggested by Dehaene.

Pre-Columbian materials throw up an even more unusual counter-example of a system like "writing"; Urton and Brezine (2005) discuss the case of *khipu*, knotted bunches of string used for communication and bookkeeping by the Incas. Although the system is difficult to translate, the chains of knotted string clearly encoded information based upon string color, as well as the type, number, and positioning of the knots. As Charles Mann (2005: 1008-1009) discusses, the implications of considering khipu as a form of writing are significant:

> If khipu were a form of writing or proto-writing, they were unlike any other. Scribes "read" the khipu by running their fingers along the strings, sometimes while manipulating small black and white stones—in striking contrast to other cultures' ways of recording symbols, which involve

printing or incising marks on flat surfaces.

In this sense, khipu were more akin to Braille than to visual writing.

Face-based writing in Mayan, pre-Columbian "writing" systems that grew increasingly divorced from language, and even khipu notation suggest that a neuroanthropological investigation of the widest possible variation of "writing" — how the brain can be trained to produce and decode a standardized symbolic system to convey information — is likely to challenge any model we have for a universal system constrained by neurology. We might chalk up all three pre-Columbian examples as anthropological oddities, outliers consigned to the archaeological record, were they not directly parallel to forms of writing still extant, or even emergent — not just Braille.

Contemporary analogues and the challenge of diversity

The case of face-based iconography in pre-Colombian writing system is especially interesting in light of the rise of face-based iconography in texting and other forms of electronic MCM, especially the widespread use of emoticons. "Smileys" and other emoticons are unlike Mayan iconography in some ways, but they are arguably even more "face-like" in that they represent emotional facial expressions themselves rather than individual persons or other ideas or phonemes. Decoding the "face-ness" of the emoticon, its stylized expression or features, is essential to understanding its meaning. Preliminary research suggests that sentences with emoticons are perceived as having nonverbal information about emotion (see Yuasa et al. 2011). New online CMC systems translate the sequences of keystrokes in emoticons (usually multiple punctuation marks) into more pictorially rich cartoon faces, demonstrating that technology is being used, not to increase neural efficiency or simplify visual stimuli, but rather to allow individuals

to communicate more richly, including using semasiographic icons not treated analogously to alphabetic writing in the brain. Some critics might say then that emoticons are not "writing" because they do not record speech, but this begs the question of what they are, especially given that they are composites of letters and punctuation marks produced during the course of writing. To disregard them as "writing" because they do not conform to a narrow definition of the activity, like disregarding the peculiarities of pre-Columbian systems, undermines any strong claim to "universality" or insistence that specific forms of writing are neurologically impossible.

Similarly, we are increasingly confronted with visual iconography not clearly tied to language, especially as the globalization of industrial production demands pan-linguistic icons on manufactured goods and information technology. With international, multi-lingual markets, semasiographic systems are proliferating on everything from microwave ovens and automobiles to smart phones. Economic forces are shaping the emergence of a new class of semasiographic signs; it may be convenient to disregard them as "writing," but they are a thorn in the side to both universal claims about the nature of writing and to simple accounts of evolution of writing toward phonemic transparency.

Finally, the case of khipu is especially striking in light of research on Braille reading. Here we have an Andean society possibly opting for a touch-based system of "written" communication as a primary sensory-sign modality rather than a compensatory one, that is, only when individuals do not have sight. Recent research on the neural correlates of Braille reading suggests that metamodal properties of the brain may make this sensory substitution easier than we might expect (see Reich et al. 2011).

In all of these cases, a simple account of cultural evolution, driven inexorably by neurological imperative toward alphabetic writing unless impeded (e.g., Dehaene 2009: 188), seems to be confounded by both cross-cultural research and contemporary cases in our own societies.

Conclusion

Anthropologists are justifiably skeptical of claims about "human universals" in cognitive research. These claims have a long history; they are seldom a conclusion derived from concerted cross-cultural or comparative research. More often, they are a rationale for *not* engaging in the sort of research that could produce a broad enough sample to justify confidence. As Henrich, Heine and Norenzayan (2011) have cautioned, our most convenient research subjects are "weird," not just because they are western, educated, industrialized, rich, and democratic, but also according to a wide range of psychometric measures. My concern, however, is not simply with the 'Anglocentricity' of contemporary reading research (see Share, 2008), or even a broader pattern of universalist claims in cognitive science on the basis of severely skewed or clearly inadequate data sets.

Rather, I am worried by the apparent *need* to assert a radical universalism, even in the face of obvious evidence to the contrary, as if cognitive theory depended upon the existence of human universals. As Coltheart argues in this issue, the claim to a universal neurological system subtending reading is difficult to sustain on any level. What I find most striking is that Dehaene, like some other cognitive scientists, seems to feel compelled to make the strongest form of the universal claim — that these systems are invariant and identical — even when he himself discusses evidence to the contrary. What is so attractive to cognitive scientists about

asserting universals, so necessary that they will disregard abundant empirical evidence to the contrary (see also Frost 2012 and accompanying commentary)?

The answer to this question is crucial to future cooperation between cognitive science and anthropology. I suspect that there is a fear that denying the strong argument for universalism, in reading or other cognitive area, means that we are condemned to radical cultural relativism. Reading is clearly highly canalized, and diversity finite. Systematic variation in writing systems — including whether systems are predominantly typographic or cursive, feature ideographs or even faced-based iconography — has predictive power for the pattern of neural activity in most readers, although, again, individual exceptions clearly exist (after all, a significant minority of test subjects does not demonstrate even the pattern of left hemisphere dominance in linguistic processing).

In fact, embracing the diversity will help us to better understand the emergence of neurological systems capable of reading in different contexts, as Dehaene's book and his other research clearly shows. Maybe other systems can be "recycled" within radically different writing environments. We can acknowledge and use cultural variation without recourse to a "blank slate" model of the brain, but only when we also recognize that strong claims of universalism are grasping beyond the reach of our data. We will only understand the nature of the neural constraints on writing when we recognize all of the different forms that are possible within those constraints; the limit cases and cultural outliers will be absolutely crucial to this effort.

I strongly share Dehaene's desire for a "neuro-anthropological" perspective (2009: 304), but we won't be able to approach it without anthropological input. Diversity must be taken seriously rather than brushed away in pursuit of strong

universals. In fact, the case of reading, so well outlined in *Reading in the Brain*, is precisely the kind of empirical case that confounds the old, single-sided perspectives — both cognitive universalism and radical cultural relativism — demonstrating that they are inadequate to the task.

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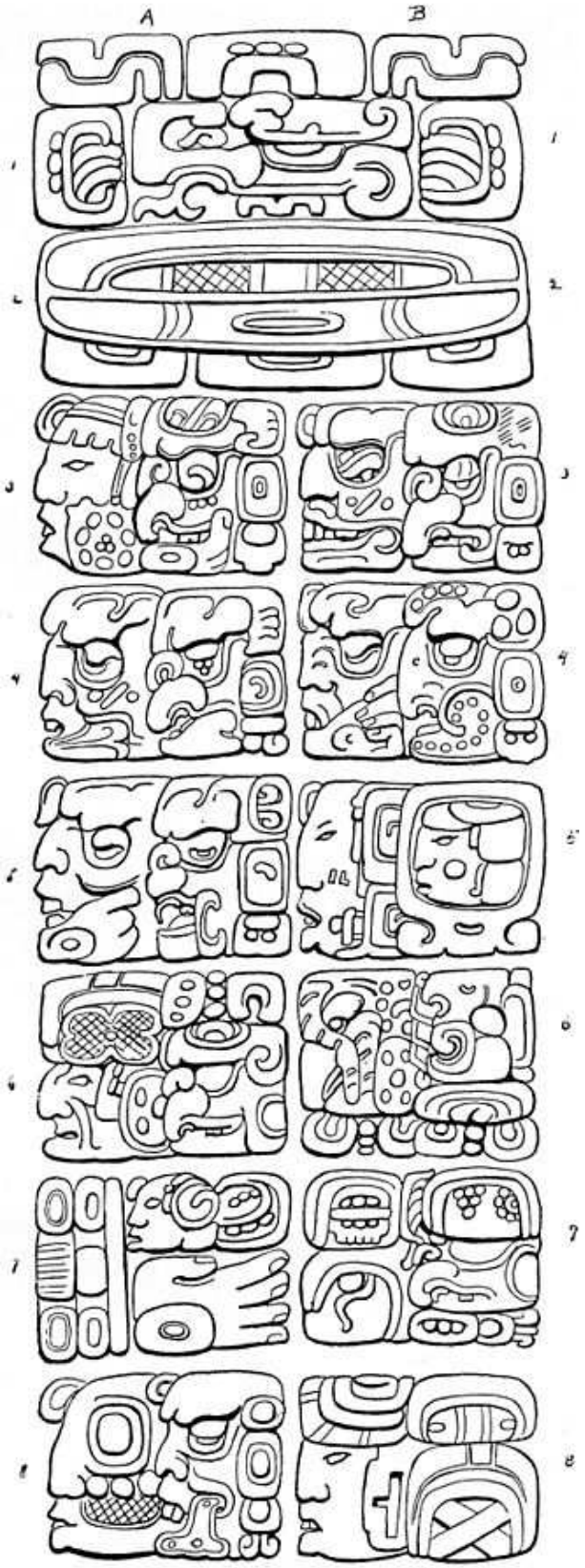
Figure 1.



Legend for Figure 1.

Initial series of glyphs on Stella F (East Side), Quiriguá, a Mayan site in southeastern Guatemala, dating to 766 C.E. The anthropomorphic signs (see especially lines 3, 4, 5, and 8) record dates and were particularly well preserved. Image from Morley 1915, p. 221. Public domain. http://en.wikisource.org/wiki/An_Introduction_to_the_Study_of_the_Maya_Hieroglyphs/Chapter_5#fig80

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[1] The Native American Sequoyah, himself illiterate, invented a system to write Cherokee, and King Sejong, together with the scholarly "Hall of Worthies" (*Jiphyeonjeon*) devised the ingenuous system, Hangul, but both were inspired by contact with extant writing systems. Sequoyah's orthography, for example, contains Roman characters adopted from English. In both cases, however, the new system was markedly different from its inspiration; Sequoyah's system was a syllabary rather than an alphabet, and Hangul was phonetic, in marked contrast to the classical Chinese script used by scholars in Korea in the fifteenth century.

[2] I have to pause to clarify that Dehaene is, I suspect, confounding *cultural relativism* as an analytical or interpretive strategy — what anthropologists do professionally — with *moral relativism*, or a nihilistic stance toward absolute truth or empirical evidence. His characterization makes it sounds as if the goal of "cultural relativism" in a field like anthropology is to *imagine* fictional cultural universes rather than understand those extant cultures which we find, including to point out when claims of universalism are disproven by empirical evidence of variation. Moral relativism is a kind of nihilism, not a professional commitment of cultural anthropologists to try to eschew ethnocentrism when they seek to understand other cultures.

[3] Changizi and Shimojo (2005) specifically exclude East Asian writing systems from their discussion. I would argue also that, although their results are striking, especially the successful prediction of shape prevalence from analysis of natural visual environments, the method they use to abstract basic shapes from letters may militate against noting outliers and bias their results toward the reduction of complex characters.

[4] One could argue that this gesture-based decoding system is also influenced by socially dominant forms of teaching, which would not invalidate the larger point

that the evolution of writing systems is driven by a number of factors, including writing technology and pedagogical techniques.

[5] "Read" is in quotes simply to indicate that this type of practice may not even be considered reading by some scholars, as it fundamentally changes the sensory channels used with technological support. There is some danger that a circular definition of reading which disregards outlying forms of reading will undermine any claim to "universality," as I discuss below with respect to emoticons.

[6] Critics suggest that the Rongorongo system of inscriptions was inspired by European exploration, but attempts to date some specimens, while inconclusive, do support the possibility that they were produced before the arrival of European ships (see Orliac 2005).