Experimental support for the DeFrancis-Unger typology of writing systems

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Introduction

Handel (2012: 159 n1 f) wishes to use the term LOGOGRAPHIC to characterize "a writing system whose graphic units represent individual morphemes of the spoken language; these [graphic] units are called . . . LOGOGRAMS." I call this approach ESSENTIALIST because it purports that every writing system has a "central organizing principle" (Sampson 1994) whereby all instances of all its graphic units (with negligibly few exceptions) represent either morphemes(or other meaningful units) or else phonemes (or other acoustical units); and that classifying the world's writing system on this basis tells us something important about them. John

DeFrancis and I (1994) disputed this claim on the basis of arguments we had presented in earlier work.[1]

Although some authors, such as Sproat (2000) and Lurie (2006, 2011), whom I will discuss later, engaged our arguments directly, Handel complains that we defined "the term logographic anew, in a way that precludes any writing system from being logographic, and thereby render[ing] the term useless as a way of characterizing writing systems like Chinese." He accuses us of "sl[e]ight of hand . . . achieved by redefining LOGOGRAM in terms of its internal structure rather than its referent, as a unit of writing that contains no visual clue to its pronunciation." But, as I shall explain, DeFrancis and I did not "simply . . . repurpose an existing technical term in a novel way." Rather, we defined it so that it can be used to distinguish PARTIAL from FULL writing.

Partial writing systems, in which visual marks are used as signals for various purposes by prearrangement among cooperating individuals, have existed from the dawn of human history, and people still improvise them. The plan may be to "read" the signs in a particular language but such systems are never co-extensive with anything like the open-ended set of utterances possible in a natural language. This open-endedness is decisive; only writing systems that are likewise unbounded are complete or full relative to linguistic competence. Because language is doubly articulated, as André Martinet famously put it, such coverage is not attainable unless some signs, at least some of the time, represent speech sounds per se, irrespective of the roles they may play in higher-level units (such as morphemes or words). The discovery that signs can stand for chunks of speech instead of things was, as DeFrancis (1984, 1989) emphasized, the rare, key event that led to the creation of full writing *ab ovo* in ancient

[1] We had summed up our position in a conference paper delivered in Toronto in 1988, which included a critical discussion of Sampson 1985, but publication of the conference volume containing this paper was delayed until 1995.

Southwest Asia, in China, and in Mesoamerica. One can hardly imagine a fact more fundamental or of greater importance for a scientific understanding of the origins, diversity, and functionality of writing systems.

After some additional remarks on this crucial point, I will summarize new results from research on the brain brought together and discussed in detail by the French neuroscientist Stanislas Dehaene (2009) that powerfully underscore the need to distinguish full writing systems from merely partial ones. There are structures in the brain that have become specialized for the handling of the former; if there are any for the latter, they are different. I will conclude with remarks that attempt to situate the issues at stake in a broader intellectual context.

A fair comparison of typologies

The theory that DeFrancis and I developed over more than two decades (DeFrancis 1989; Unger 1990, 1992; DeFrancis & Unger 1994;DeFrancis 2002; Unger 2004, 2011, 2013) is grounded in the undisputed fact that all naturally occurring writing systems deploy graphic units in two ways: to represent speech sounds (phonemes or syllables) and to represent linguistically meaningful combinations of speech sounds (morphemes or words).As just explained, however, only writing systems that do the former as well as the latter can accommodate the enormous potential output of a natural language. Theoretically, one could imagine, as does Sampson (1985), a tribe of people who “possess two fully-fledged ‘languages’ [one spoken and one written] having no relationship with one another,” but no example of that sort has ever been observed. No satisfactory typology of writing systems can fail to account for such a basic, empirical fact.

Moreover, in all full writing systems, the ratio of phonographic and logographic deployments of graphic units does not, for easily understood reasons, stray very far from a central mean value. On the hand, recording purely phonetic details of utterances in writing adds no distinctive information to a text. It merely makes it longer and more unwieldy than necessary. On the other hand, the more one underspecifies speech sounds or uses abbreviations to shorten texts, the harder it becomes to learn the writing system as a whole. Usability and learnability must somehow be balanced. This is why DeFrancis subtitled his 1989 book “the diverse oneness of writing systems.”There are several ways to achieve a practical balance, but practicality takes priority over inventiveness and constrains it.

Since English and Chinese texts look very different graphically, one might think their respective writing systems must operate according to completely different principles (allegedly “phonographic” and “logographic”), but English and Chinese are not even close, respectively, to genuine cases of extreme phonography and logography. Detailed phonetic notations used by field linguists contain almost no logographic graphic units; military codes contain virtually no phonographic graphic units. Both kinds of writing are full, not partial, because they can transcribe all the potential utterances in a natural language, or at least a large, open-ended set of them. It does not matter that texts in fine-grained phonetic notation are hard to compose, compare, and read, or that using the contents of a thick codebook from memory is nearly impossible. Extreme writing systems of these kinds are deliberately designed to sacrifice usability or learnability for the sake of acoustical detail or secrecy. Most full writing systems, with a few exceptions like King Sejong’s alphabet and Sequoya’s Cherokee syllabary, were not deliberately designed; they evolved over long periods of time to serve general purposes.

Sampson (1994), to whom DeFrancis and I responded the same year in the same journal, admitted that all writing systems combine phonographic and logographic “principles,” but dodged the implications of this fact by saying:

> Whether one regards . . . a system as essentially logographic with elements of a phonographic principle, essentially phonographic with elements of a logographic principle, or as too mixed to assign to either category, must depend on a subjective judgment as to how close and regular the relationship between pronunciations and written forms need to be before one treats the relationship as the central organizing principle of a script.

But this merely begs the question—why must every writing system have a "central organizing principle"? When it comes to whole writing systems, we replied that"[u]nless one has hard data (not just classificatory theories) showing that the processing of, say, English texts and Chinese texts in the brain proceeds along different pathways, the hypothesis of a single mechanism must be preferred." Today, as Dehaene explains, there are hard data proving that the brain has different networks of connections for dealing with phoneme and morpheme recognition. But the data also show that both networks work together, in parallel; are activated only after retinal image processing, invariant letter recognition, and hierarchical assembly of larger graphic units have begun; and are the same for all full writing systems.

Before tracing what happens in the brain further, let me return to Handel's criticism briefly. It is true that DeFrancis and I defined "logogram . . . as a unit of writing that contains no visual clue to its [the referent's] pronunciation," but one needs to be careful about what constitutes a unit and how graphic structures give clues.

The functional units of a writing system are typically not its smallest identifiable graphic units. They belong rather to what Lakoff (1987) calls a middle-level category. The orthographic word of English, the syllabic block of Korean, or the individual character of Chinese are all such middle-level or BASIC units. They can almost always be broken down into smaller elements that recur allographically in other basic units. Those smaller elements are usually phonographic, yet when a basic unit corresponds to a morpheme, they typically underspecify its phonemic shape. Moreover, basic units sometimes correspond to more than one, or to only part of one, morpheme. In all these ways, Chinese characters and orthographic words of English, for example, are similar. The gross difference between the number of Chinese characters and number of letters in the alphabet is misleading, and the impression it gives of different “organizing principles” being at work is false.

Furthermore,one and the same basic unit may work phonographically in one context but logographically in another, or in both ways at the same time. One can at least tell from context, most of the time, when one kind of function is NOT being performed. For example, in the usual way of writing the Chinese word *dàxué* ‘university’ 大学, neither character is a logogram in the strong sense Handel prefers because, synchronically, this word is just a single two-syllable morpheme. The characters could perhaps be described as logographic ETYMOLOGICALLY, but etymology is not meaning, and speakers unaware of a word’s etymology can still learn and use it properly. Yet the characters for the adjective *dà* ‘big’大 and verb *xué* ‘study’ 学 are phonograms only in the weak sense that someone acquainted with the writing system will not confuse these characters with others that look similar. Beyond that, decomposing them into strokes provides no help: as symbols for *dà* ‘big’ and *xué* ‘study’, they are logograms, and the links between the characters and the morphemes must be learned by rote. The role played by a sign is not the same in all contexts.In each, there can be a different relationship between the elements (groups of strokes, letters) that constitute the form of the sign graphically and the linguistic elements (phonemes, meanings) that constitute the referent synchronically.

Logographicity (or its inverse, phonographicity)is just the name of a scalar value that quantifies this relationship. The idea of such a scale was not original with DeFrancis or me, but we emphasized that it is CONTEXT-

SENSITIVE. Essentialists like Sampson want "logographic" and "phonographic" to be context-free descriptors—hence the way he speaks of the "central organizing principle" of a writing system.[2] But this forgets the fundamental difference between partial and full writing.

Dehaene's account of reading

The fact that literacy is historically recent links DeFrancis's analysis with Dehaene's. For DeFrancis, it proves how hard it was to discover that visible signs could stand for speech sounds. Without that, there could be no full writing. For Dehaene, it proves there was not enough time for specific brain structures and circuitry to have evolved by natural selection for literacy. Yet he can identify them. Therefore, Dehaene argues, neuronal regions and circuits that had evolved to serve other purposes must have been re-appropriated for literacy.[3] In the on-line summary of his book, he states his view concisely as follows:

> Written word processing starts in our eyes. Only the center of the retina, called the fovea, has a fine enough resolution to allow for the recognition of small print. Our gaze must therefore move around the page constantly. Whenever our eyes stop, we only recognize one or two words. Each of them is then split up into myriad fragments by retinal neurons and must be put

[2] The "principle" of a writing system, like "the genius of the French language" (at the end of the first paragraph of Lytton Strachey's *Landmarks of French Literature*, 1912), may be an acceptable turn of phrase but is hardly more substantial or worthy to serve as a term of scientific linguistics.

[3] While Dehaene is as opposed to the *tabula rasa* view of the brain as Pinker (1997), whose boundless enthusiasm for a computational theory of mind attracted criticism even from its leading exponent, Jerry Fodor, Dehaene's neuronal recycling hypothesis is much closer to a hypothesis of the embodied knowledge theory: brain modules used for the senses and motor functions also generate mental simulations; mental simulations about utterances are their meanings. Meaning, on this account, is private and context-dependent (Bergen 2012).

> back together before it can be recognized. Our visual system progressively extracts graphemes, syllables, prefixes, suffixes, and word roots. Two major parallel processing routes eventually come into play: the phonological route, which converts letters into speech sounds, and the lexical route, which gives access to a mental dictionary of word meanings.

Dehaene thus points to physical correlates of phonography and logographyas inherent aspects of all full writing. Moreover, he explains, the bits and pieces of retinal perception are not the minimal graphic units upon which Sampson dotes. We know how the brain synthesizes the units it works with from raw visual data.

> In 1892, the French neurologist Joseph-Jules Déjerine discovered that a stroke affecting a small sector of the brain's left visual system led to a complete and selective disruption of reading. Modern brain imaging confirms that this region plays such an essential part in reading that it can aptly be called "the brain's letterbox." Located in the same brain area in readers the world over, it responds automatically to written words. In less than one-fifth of a second, a time span too brief for conscious perception, it extracts the identity of a letter string regardless of superficial changes in letter size, shape, or position. It then transmits this information to two major sets of brain areas, distributed in the temporal and frontal lobes, that respectively encode sound pattern and meaning.

Three points here deserve particular attention: First, the location of small letterbox region is independent of language and culture. Second, phonological recoding and morpheme recognition are competing parallel processes. And third, those processes begin only when the letterbox area supplies them with analogues of the basic graphic units that DeFrancis and I discussed. Indeed, Dehaene makes an interesting observation about Chinese readers. Their letterbox area

> prefers proper Chinese characters to visually similar meaningless shapes. This property is strictly analogous to the greater response to words rather than [non-word] consonant strings observed with alphabet users. It demonstrates that this region has adapted itself to the constraints of Chinese writing. Rather than letters, a Chinese reader's letterbox area must contain a hierarchy of detectors tuned to the semantic and phonetic markers that make up the internal structure of Chinese characters.
> In fact, I know of little data to support the idea of a 'holistic' recognition of Chinese characters. The experimental results that are available suggest rather that Chinese characters, much like letter strings, are coded as a hierarchical pyramid of increasingly large bundles of visual features (2009: 98).

"In ALL cultures," Dehaene concludes, "the same area in the left occipito-temporal region is in charge of written word recognition, exquisitely adapting its hierarchical architecture to the specific requirements of each writing system" (2009:100; emphasis JMU).

Figure 1explains the discovery and significance of the letterbox area. Data generated by it corresponds to basic graphic units (orthographic words, characters, etc.). Figure 2shows how they get processed. The brain first tries to recover speech sounds, then resorts to lexical recognition. Dehaene describes the trigger in terms of "regular" versus "irregular" spellings, but, as previously explained, one and the same basic unit may be phonographic (i.e. "regular") or logographic (i.e. "irregular") depending on its context. Indeed, 〈carrot〉 in Figure 2is a good example of a basic unit that is neither completely one or the other. The same can be said of a so-called phonetic-signific compound character in Chinese, such as 〈请〉.This character has a phonetic component *qīng* 青 that provides a heuristic clue to the pronunciation of the word 'please' qǐng 请,with third rather than first tone, much as 〈carrot〉 approximates the phonemic string /ˈkærət/. To say that either is a phonogram or a logogram depending on somebody's subjective judgment, as Sampson would have it, seriously distorts the psycholinguistic facts.

Figure 3demonstrates that Dehaene accepts a scale of transparency similar to the one that DeFrancis (2002:16) and I (2004:32; see Figure 4) proposed. He even provides brain images highlighting the different degrees in transparency among four alphabetically written European languages. The addition of an orthogonal “size of units” axis in no way diminishes the connection between Dehaene’s horizontal scale and the one DeFrancis and I proposed. Of the vertical axis, Dehaene writes as follows:

> All writing systems, finally, tend to jointly represent sound and meaning. It is as though the ancient scribes were aware that our letterbox area’s connections make it a hub that projects shape information both toward the superior temporal regions coding for speech sounds and to the middle and anterior temporal regions coding for meaning. Whether sound is privileged rather than meaning is one of the main sources of differences between writing systems (see figure [3]). In all of them, there is always some statistical correlation between written marks and speech sounds—but the size of the speech unit transcribed ranges from whole words (in Chinese or Japanese Kanji) to syllables (in Japanese Kana), phonemes (in alphabetic writing systems), or even isolated phonetic features (in the case of Korean Hangul writing). Brain physiology does not regulate this domain, but the choice of the speech unit to be rendered ultimately determines the number of written symbols and hence the complexities of reading acquisition. (Dehaene 2009: 176)

As the last sentence makes clear, the size axis is important mostly because it measures the intensional diversity of the basic graphic units in a system, which roughly determines how hard it is to learn.[4] Nevertheless, the brain

[4] Roughly speaking, the INTENSIONAL value of a sign depends on what other signs in the system it can contrast with. Its EXTENSIONAL value depends on what things outside the system it could refer to.

deals in the same way with whatever the language and its writing system present it with. The list of different kinds of writing is obviously taken from the pages of Sampson 1985, and Dehaene seems to have included it because he is unfamiliar with non-European writing systems. This is indicated by his use of the rarely seen characters 京 and 剅, and strange *kana* example ぎして in Figure 3. Likwise, in the narrative, the separation of *kana* from *kanji* makes no sense except in experimental conditions, in which they are tested independently: in actual modern Japanese writing, they are always used together. Moreover, Japanese *kana* represent morae, not syllables, which may consist of one to three morae. For this reason alone, *kana* are unlike *devanāgarī* letters; in addition, in *devanāgarī* writing, a vowel, or the absence of a vowel, is usually indicated with a diacritic, and ligatures disrupt the one-to-one correspondence of letters with speech sounds. Finally, not all Chinese characters represent a morpheme, let alone a word, all the time. The important feature of Figure 3is thus the horizontal axis, which shows that Dehaene implicitly accepts the role of context in determining the degree of transparency of various instances of writing.

Look once again at the legend of Figure 2: The brain cannot know a priori the extent to which 〈carrot〉 is or is not a “regular” spelling because regularity is an intensional feature of the graphic unit 〈carrot〉. How it stands in relation some presumed ideal phonemic target requires that the brain at least attempt to recode it phonologically. In this particular case, the fact that there are homophones—〈carrot〉, 〈karat〉, and 〈caret〉 are all pronounced /ˈkærət/—makes this especially clear. The extent to which any of them is a “regular spelling” depends on whether phonological recoding wins the race with lexical access in a particular context. If the meaning emerges before phonological recoding is completed, then the basic unit evidently worked logographically, but phonological recoding often wins the race. Had Dehaene consulted such works as Horodeck 1987 and

Matsunaga 2002, he would have found experimental confirmation for this: if one replaces a character in a text with a visually similar but false character—e.g. 埋投 for 埋没 *maibotsu* 'bury' or 予側 for 予測 *yosoku* 'forecast')—Japanese readers will spot the error about five times more often if the false character cannot take the reading demanded by the context. That is, 埋投 will be caught because 投 is never read *botsu* whereas 予側 will typically slip by because 側 can be read *soku*. Thus, when the contextually correct sounds are triggered before lexical access is completed, the orthographic lexicon may be effectively bypassed and the semantic lexicon is accessed by way of the phonological form, as it is in ordinary listening.

Furthermore, there is a growing body of experimental evidence showing that the meanings of many words and sentences arise from mental simulations of handling mentioned objects or moving the body in mentioned ways (Bergen 2012). In these experiments, the linguistic cues are generally provided in writing and are read by subjects, who then react in controlled ways; their reaction times are measured from the first presentation of each stimulus text. Therefore, though Bergen emphasizes that the results of these experiments prove that mental simulations in the motor strip of the cortex occur as part of semantic interpretation, these experiments also support the time sequencing implicit in Figure 2.

Moving beyond essentialist typology

As remarked in the Introduction, Handel is not alone in misreporting the alternative to essentialist typology that DeFrancis and I put forward.

Lurie (2006), adopting a postmodernist stance, does not beg the question as does Sampson, but argues instead that scientific linguistics as a discipline has no authority. Much as Stephen Jay Gould (1997) famously argued that, on spiritual matters, science and religion constituted "mutually exclusive magisteria," each sovereign in its own epistemic domain, Lurie argues that practitioners of literary and cultural studies need pay no heed to linguistics, anthropology, or any other discipline in the scientific paradigm.[5]

Sproat's reply (2013) to Unger 2011, by contrast, remains loyal to the scientific enterprise. Acknowledging that, in Chinese, "it cannot be the case that each and every morpheme can be written with a single character," he agrees that "if we take 'logographic' to mean that each morpheme must have a distinct single-character representation, then it . . . follows that Chinese writing cannot be logographic." "But," he continues, "it is still possible that each Chinese character represents a morpheme(or possibly several morphemes, allowing for homographs), though not all morphemes have a single character representation" (109). The problem with this argument is that it fails to distinguish true morphemes of modern Chinese from glosses (in any language) and premodern lexical senses. Using the latter, one can indeed come up with a rubric for every character, but that does not mean the character actually represents the morpheme corresponding to the rubric every time it is used. Again, etymology is not meaning, and even a character that represents a morpheme in one situation may be phonographic in another.[6]

Handel's critique of the DeFrancis-Unger typology of writing systems falls somewhere between these poles: it is more serious than Lurie's, but not as forthright as Sproat's. DeFrancis and I did not use verbal legerdemain to preempt the claim that the Chinese writing system is logographic. What we did was rather to present evidence showing that middle-level—not necessarily the smallest—graphic unitsof all full writing

[5] Lurie 2011 makes matters worse by using a misstated version of DeFrancis's and my theory as a straw man.
[6]For additional discussion of Sproat's argument, see Unger 2013.

systems manifest varying degrees of logographicity (or phonographicity) depending on both intensional and extensional contexts. This indeed makes it impossible to claim that whole writing systems are either phonographic or logographic “in principle,” and that the allegedly logographic ones (Chinese and Japanese) are irremediably different from the rest, but there is no terminological trickery involved. We made a testable, empirical claim, and the findings summarized by Dehaene back us up. Although new discoveries will undoubtedly emerge with further research, it is already abundantly clear that the brain pays little attention to the classes of writing systems claimed to exist in essentialist typology.

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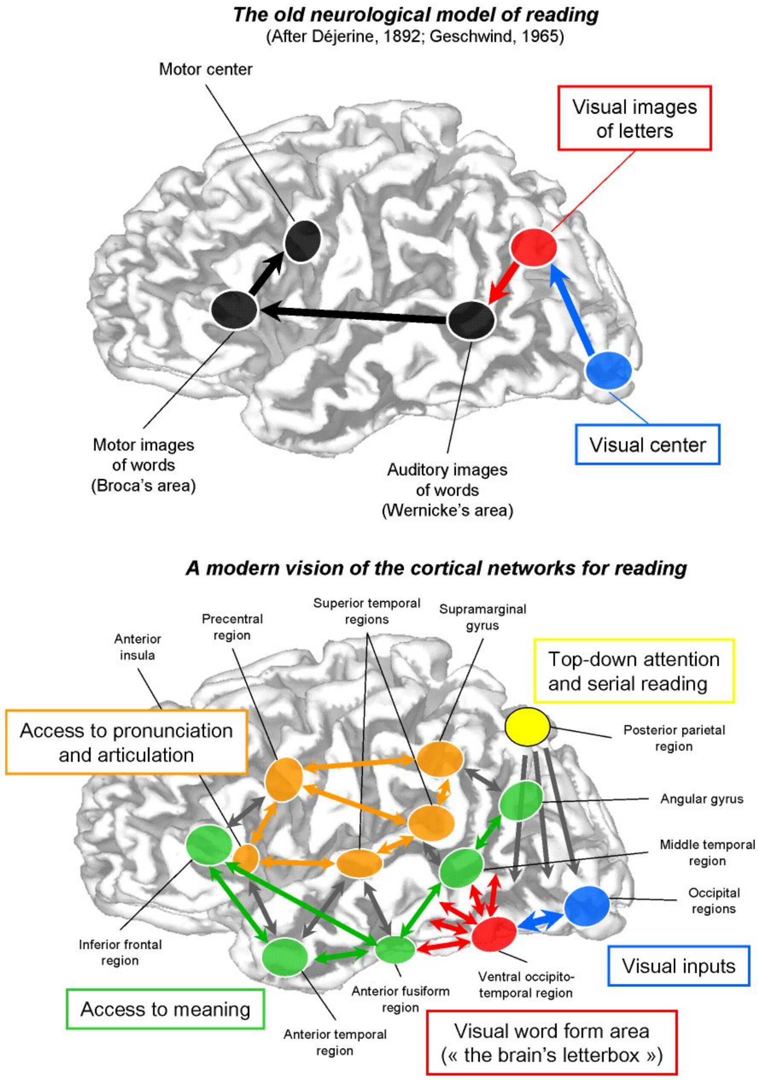

Figure 2.2. The classical neurological model of reading (top) is now replaced by a parallel and "bushy" model (bottom).The left occipito-temporal "letterbox" identifies the visual form of letter strings. It then distributes this invariant visual information to numerous regions, spread over the left hemisphere, that encode word meaning, sound pattern, and articulation. All the regions in green and orange are not specific to reading: they primarily contribute to spoken language processing. Learning to read thus consists of developing an efficient interconnection between visual areas and language areas. All connections are bidirectional. Their detailed organization is not yet fully known – in fact, cortical connectivity is probably much richer than suggested in this diagram.

Figure 1

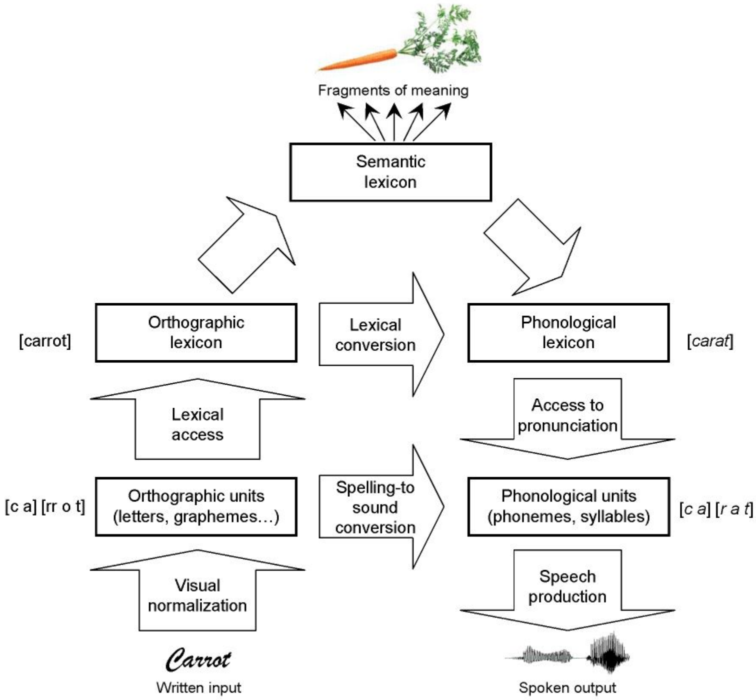

Figure 1.4. Word reading proceeds along several parallel processing routes. To move from the written word (bottom left) to its pronunciation (bottom right), our brain relies on several pathways, indicated here with boxes and arrows. When the word is regular, a surface route directly converts its letters into speech sounds. When the word is irregular, such as "carrot", deeper representations are involved. They can be compared to mental lexicons that attach word form to meaning.

Figure 2

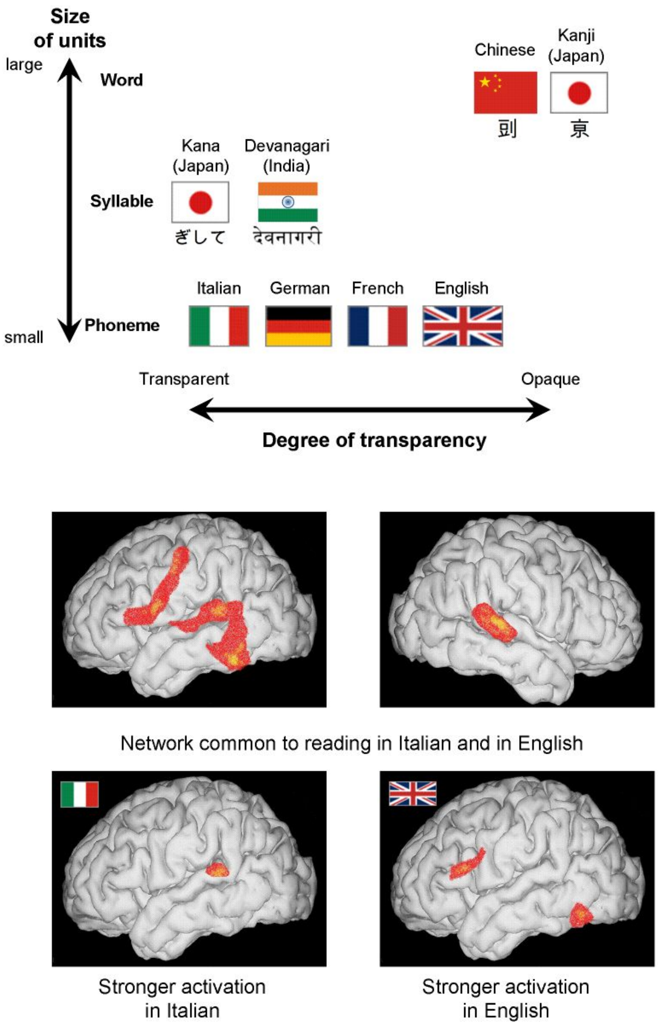

Figure 2.20. The transparency of the spelling system influences the organization of the reader's brain. Writing systems differ in the size of the units they denote (phonemes, syllables, or whole words) and in their degree of transparency (the regularity of the relation between symbols and speech sounds). Italian spelling is very regular, while English spelling bristles with irregularities and exception words. When contrasting brain activations in Italian and English, small modulations are seen within an overall shared network. Italian causes stronger activation in auditory areas of the superior temporal lobe, while English puts greater emphasis on the occipito-temporal area as well as on the left inferior frontal region (after Paulesu et al., 2000).

Figure 3

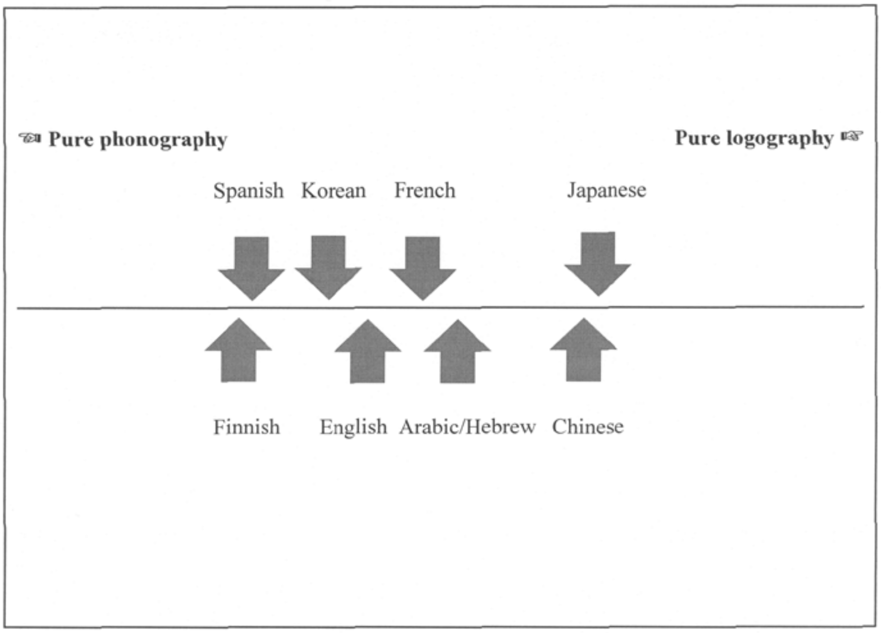
☜ Pure phonography
Pure logography ☞
Spanish
Korean
French
Japanese
Finnish
English
Arabic/Hebrew
Chinese

Figure 4

Discussion: Experimental support for the DeFrancis-Unger typology of writing systems

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Reading Prof. Unger's paper, I was reminded of the controversy concerning distinctions between idioms and free combinations of words. I think examining that topic can shed light on the question around logography and phonography.

Traditionally, idioms had been considered to be completely opposite to free combinations of words. The former is semantically opaque or non-compositional, whereas the latter is semantically transparent and regular. In principle, idioms can be interpreted idiomatically or literally, so many scholars thought that the processing of idioms would require more time than free combinations would do. However, recent psycholinguistic experiments have shown that idioms are no different from free combinations in terms of processing time, which means that both are processed essentially in the same way. On the basis of this fact, some scholars maintain that the distinction between idioms and free combinations is untenable and an artifact constructed by linguists, and idiomaticity is pervasive in every aspects of language. On the other hand, more linguists, conceding the experimental results and their theoretical implications, think that the distinction between idioms and free combinations can be maintained. Idiomaticity is indeed the question of degree: some expressions are more or less idiomatic than others, and it is difficult to draw a clear boundary between idioms and free combinations. However, because one cannot draw a clear boundary does not mean that there cannot be a distinction of categories. The green area and the blue area of a rainbow cannot be distinguished by a clear boundary from each other, but most people accept the two color categories. By the same logic, idioms and free combinations can be thought of as two categories, even if we concede that there is no sharp boundary between them.

As Prof. Unger argues, recent experimental results show that there is no principled distinction between the processing of logographs and that of phonographs. All full writing systems contain some elements of both phonography and logography. On the other hand, it is also an undeniable fact that there is quantitative differences in the ratio of phonographic and logographic elements among various writing systems. Therefore it is possible to posit two categories, i.e. logographic writing system and phonographic writing system, although there is no sharp boundary between them.

I think Prof. Unger's point is overall on the right track, but it is not a wise strategy to fight with the dichotomy of logography and phonography. Rather, he had better seek for reconciling his point and the traditional categories.