

Observations from the Sidelines

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Isabelle Liberman had long believed that if she and her colleagues were to understand dyslexia or, more generally, reading, they had first to deal with the characteristic of language that is most directly relevant: the vast difference in naturalness (hence, difficulty) between its spoken and written forms (Liberman, 1971; Shankweiler and Liberman, 1972; Liberman, I. Y., Shankweiler, and Liberman, A. M., 1989). In a state of nature, everybody speaks, nobody reads. Thus, alexia is the biologically normal condition; what we call dyslexia is simply the inability to rise above it. It therefore seemed to Isabelle the merest common sense to suppose that knowing why reading is relatively difficult for all would likely reveal why it is inordinately difficult for some.

The obvious key to the difference in naturalness between the spoken and written forms of language is in the fact that speech is a species-typical product of biological evolution, while writing systems are artifacts. The less obvious corollary is to be found in the strikingly different ways by which systems with such disparate courses of development meet a requirement that is imposed on all forms of communication, whether evolved or invented. This requirement, which goes to the heart of questions about the genetic and neurological bases of communication, is what Mattingly and I have called 'parity': sender and receiver must be bound by a common understanding that only certain signals, or, more properly, their perceptual representations, have communicative significance; otherwise, communication cannot occur (Mattingly and Liberman, 1988; Liberman and Mattingly, 1989). Given that speech was a result of evolution, not invention, we know that parity cannot have been established by convention. It had, rather, to be built into the underlying biology, and that was accomplished by the development of a specialization for speech, a biologically coherent device specifically adapted to recover the linguistically relevant articulatory gestures of the speaker, and so to produce percepts that are, *ab initio*, of a distinctly phonetic cast. Indeed, speech percepts cannot be auditory in the ordinary sense, for if they were, then only a deliberate cognitive process could have marked them for linguistic significance, and so attached them to language. In that case, our ancestors would have had to agree to call certain otherwise undistinguished auditory representations by phonetic names, and then pledge to use them exclusively for linguistic purposes. But speech percepts did not have to be

named; as Studdert-Kennedy aptly put it, they 'name themselves' (Studdert-Kennedy, 1976). Unlike the ordinary primitives of pitch, loudness, and timbre — primitives that form a countless variety of identifiable percepts — those of the phonetic modality are used only for language; having evolved for a specifically linguistic purpose, they are simply no good for anything else. This is to say that speech percepts are specifically and exclusively phonetic as they are immediately represented to cognition by the speech specialization. No cognitive translation from auditory primitives is necessary. Accordingly, the phonetic representations evoked by the sounds of speech are, by their very nature, integral parts of language; they are not merely vehicles for conveying it. Speech puts the listener immediately into the language system (Liberman and Mattingly, 1985; Mattingly and Liberman, 1988).

A writing system is a different matter altogether. There, the letters of the alphabet evoke percepts that are unremarkably visual; they are not inherently linguistic, for there is no specialization to make them so. Indeed, the probability that there is a specialization for reading is exactly equal to the probability that there is a specialization for playing poker. Therefore, parity can only have been established by convention. Someone had to decide that certain optical shapes, and only those shapes, should be considered to have linguistic significance, which is exactly what it means to say that writing systems are artifacts. In consequence, it is left to the reader to confer linguistic status on nonlinguistic percepts, and this requires of him a cognitive step that the speech perceiver need not take. Of course, a reader might decline to take that step, electing rather to make do with representations that bear no organic relation to language. Thus, at the first stage, the reader might develop a purely visual lexicon. On that strategy, however, he would not only be required to do the same lexical job twice, but, for the purpose of reading, he would be unable to do it the way nature intended. After all, phonological processes evolved as part of the specialization for language just to make it easy for humans to create, acquire, store, and access the tens or hundreds of thousands of words that a lexicon typically comprises.

The price of such a nonlinguistic strategy is seen to be the more steep when one considers that phonological structures are presumably the raw materials on which syntactic processes normally work. Must a reader cobble together a set of cognitive processes that are not specialized for language, and for which he has no natural affinity, just in order to do a syntactic job on representations that remain stubbornly nonphonological? Surely, that would be hard to do; indeed, it might not even be possible.

The seemingly sensible strategy for the reader is to use the optical shapes to access the phonological structures early in the reading process. Once the reader has done that, he has put the hard part of reading behind him, for everything else will be done automatically by language processes

that he commands by virtue of his humanity. But connecting the optical characters to the phonology is not so easy as it might seem. At the very least, it requires more than just knowing what is called, in 'phonics' instruction, the 'sounds of the letters'. In fact, learning to attach those sounds to the letters is trivially easy for almost everyone; unfortunately, it is only marginally helpful and may, indeed, be hurtful. As Isabelle pointed out so many times, it avails the reader little to know that the [b], the [a], and the [g] of [bag] are pronounced [buh], [a], and [guh], for that will most likely lead him to [buhaguh], which is the wrong word. What he must know is that a word like [bag] is formed of three phonological units; only then does it make sense to him that it should be spelled with three letters. To see that this is a cognitive achievement of sorts, one need only consider that, while our ancestors had presumably begun to speak about the time they emerged as a distinct species, they had to wait until a few thousand years ago for the discovery by one of their number that every word they spoke had an internal phonological structure. This momentous discovery was readily translated into the alphabetic principle, a triumph of applied biology that was the necessary precondition for the invention of the mode of reading and writing we all use. Unfortunately for the would-be reader, however, the proper use of this invention requires a conscious grasp of the underlying principle, as opposed to a tacit command of the phonological structures it captures, and this conscious grasp does not come as standard equipment on the linguistic faculty we all inherit.

So what stood in the way of the discovery by our ancestors that the words they spoke so effortlessly all had a phonological structure? Why should it have been relatively hard for them, and now for us, to develop what Isabelle and her colleagues have called 'phonological awareness'? The first consideration, of course, is that, as we have already seen, such awareness is not required for speech. In that natural mode, the speaker need only think of the word; the speech specialization spells it for him, automatically selecting and coordinating the gestures that define its phonological units. As for the listener, he need not consciously and effortfully parse the speech signal; again, the speech specialization takes over, recovering the phonological structure that distinguishes the word and forms the basis for all further linguistic work that will be done with it.

Thus, there is nothing in the speaker's experience with speech that requires him to be aware of phonological structure. But there is more to the matter than that, because there *is* something in speech that actually tends to make that awareness more difficult than it would otherwise be. That something is coarticulation, the process that, in all languages, overlaps and merges the gestures that define the phonological elements. This species-specific aspect of the phonetic specialization was critical in the evolution of speech, because it made possible the high rates (reaching 15 or more phonological segments per second) that normal speakers achieve.

It was also critical for speech perception, because, by folding several phonological segments into a single piece of sound, it relaxed the constraint on rate of perception that is set by the temporal resolving power of the ear. But the consequence for the would-be reader is less happy, for he must contend with the fact that, because of coarticulation, the phonological segments do not generally correspond in any straightforward way to the acoustic segments. In a word like [bag], as in most words, the phonological information is so thoroughly overlapped and smeared that there is simply no acoustic criterion by which it can be sorted out and so made perfectly apparent to the consciousness of speaker and listener (Liberman, Cooper, Shankweiler, and Studdert-Kennedy, 1967). Still, the underlying phonological structure *is* available to consciousness, as the existence of skilled readers proves, but only at the cost of a cognitive effort.

Why, then, should the cognitive achievement that phonological awareness represents be more difficult for some than for others. The view favored by Isabelle and her colleagues is not that these dyslexics are lacking in cognitive resources, but only that they suffer from a deficiency — presumably a mild one — in the phonological component of their specialization for language, and that this causes some reduction in the clarity or robustness of the phonological representation (Liberman, Shankweiler, and Liberman, 1989). If these representations are weak, then they should be that much less readily available for conscious inspection. But difficulty in achieving phonological awareness should not be the only symptom of a weakness in the phonological system. We should also expect to find constraints on short-term memory for verbal materials (working memory, as it is sometimes called), together with somewhat greater than normal difficulty in perceiving speech in noise, in finding the phonological structures appropriate to naming objects, and, given that production is the other side of the special phonological coin, in executing difficult articulatory maneuvers. As for the genetics and neurology of dyslexia — the subjects of this conference — is it not plausible to suppose that individual differences in a coherent and recently evolved specialization should exist and be heritable?

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