The Evolution of the Speech Instinct in Silent Reading

Implications for Technical Communication

Bradford R. Connatser

132-G Durwood Lane

Knoxville, Tennessee 37922

423-974-8316, Fax: 423-974-8289

email: cwrites@usit.net

THE EVOLUTION OF THE SPEECH INSTINCT IN SILENT READING IMPLICATIONS FOR TECHNICAL COMMUNICATION

BRADFORD R. CONNATSER
Power Electronics Applications Center
Knoxville, Tennessee

ABSTRACT

When people read silently, they unconsciously translate what they read into a speech-like code that facilitates word identification and the creation of meaning, especially when they read scientific and technical texts. Many studies have explored how this "silent speech" affects the reading process. As a follow-up to a previous paper about applying a phonological reading model to technical communication, this article proposes that educators and practitioners of technical communication would benefit greatly from a thorough understanding of the speech instinct. Therefore, the author explores the speech instinct, how humans developed it, and how it has been and still is fostered by reading behavior and pedagogy.

INTRODUCTION

The creative powers of speech have played prominently in the world's literature. Consider, for example, the creation story in the Bible. God did not hunker over the world and create everything with his hands; he used his voice: "And God said, Let there be light: and there was light." Other appreciations of speech are not hard to find. Even in our everyday lives, we indulge a powerful compulsion to speak: to remember a telephone number, to cope with complication (a mantra, for example), to spontaneously convey our thoughts and emotions. And during silent reading, this same speech instinct not only manifests itself but also underpins a reader's comprehension of a text.

A great body of evidence demonstrates that the words we read are translated into a speech-like code that greatly facilitates the reading process, and when this "silent speech" is disrupted or suppressed, word identification and short-term memory are significantly impaired [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]. And, according to Baron, the reader relies most upon this speech code "when reading difficult scientific papers" [9, pp. 195–96]. Specifically, the speech code:

- helps lexical access by speeding up word identification [6]

- helps short-term memory keep meaningful units of information in an active state so that the information can be semantically integrated with other information from long-term memory [13]
- helps editors detect errors [3].

As an illustration of how the speech instinct bursts upon us when we read silently, read this sentence taken from an article in the *New Yorker*: "This summer, ☥ begins his first American tour in three years. . ." [15, p. 60]. The article is about the rock star formerly known as Prince, who changed his name to the symbol ☥. Do you feel the power of the speech instinct compelling you to articulate the symbol? Yet the symbol has no sound correspondence. The result is a frustration of the speech instinct.

The results of disregarding such a powerful component of the reading process is evident in the prose of novice writers, who unwittingly introduce into a text elements that are not readily translated into speech: for example, choosing an article based upon the spelling of an initialism and not its sound (a FBI agent); introducing an esoteric, difficult-to-pronounce word or proper name without offering the reader a key to its pronunciation; omitting punctuation marks that indicate stress and pitch, the navigational buoys of the speech stream; and using unpronounceable constructions such as "s/he." Applying knowledge of silent speech to technical communication can yield techniques that writers of all skill levels can use to compose technical documents according to the way people actually read them [16].

I suggest that teachers and practitioners of technical communication would benefit greatly from a thorough understanding of the speech instinct in the context of technical communication. Specifically, they will benefit from understanding how humans developed the speech instinct and how it has been and still is fostered by reading behavior and pedagogy. The notion that silent speech is merely the whir of reading machinery, argued by Smith [17] and others, will be challenged by evidence from many disciplines, including physiology, anthropology, and history. Evidence of a powerful speech instinct in silent reading may encourage a serious, systematic treatment of silent speech in the classroom, especially in the teaching of science and technical communication.

THE DEVELOPMENT OF THE SPEECH INSTINCT

The story of human speech begins some three million years ago, when the primate *Australopithecus Africanus* roamed Africa and competed with other animals for food and shelter. The fossil record of his existence speaks of

many things but is silent about his linguistic endowment. He made no tools, no significant changes to his environment, and left little or no evidence of his mental capacity [7]. The process of cultural evolution did not begin until a few million years later, when *Homo habilis* (handy man) fabricated rough stone implements—evidence of human syntax, the ability to understand and create consequential relationships between things in the mind and extrapolate those relationships to the physical world. Then, "during the million-year transition from *Homo habilis* to *erectus*, the neocortex, which became the principal center for association and thought, more than doubled in size" [18, 1996, p. 9].

Even so, the earliest substantial evidence of language use dates back no further than 200,000 years ago—the epoch of *Homo sapiens* and *Neanderthal* [7, 19]. The fossil record speaks effusively about their linguistic endowment. Whereas *Australopithecus Africanus* "had a vocal tract virtually identical in form to that of the chimpanzee" [7, p. 142], the vocal tracts of *Homo sapiens and Neanderthal* were well evolved. The larger oral cavity of *Neanderthal* fossils indicates that vowels like /i/, /u/, and /a/ could not be produced. Additionally, computer modeling suggests that the *Neanderthal* vocal tract could not produce the consonants /g/ and /k/, but could produce /b/, /d/, /s/, and /z/. *Homo sapiens* of the same period, however, had the articulatory capabilities of modern man.

The biological changes in tongue, palate, and throat structures imply an ability to encode discrete symbols into a continuous stream of sound (to speak), which in turn implies an ability to decode the sound into discrete mental concepts (to hear). Therefore, we can assume that human cognitive ability and language were fully evolved by about 200,000 years ago.

Within the last 200,000 years, a developing human culture and advances in technology placed a great selective advantage on enhanced linguistic ability. As people traded technologies and cultural artifacts, the speech apparatus became essential to the new ways of living. As Darwin pointed out, it is not difficult to imagine why speech communication developed instead of other types of communication, such as hand signals. First, the use of our hands to communicate would "be a serious inconvenience" [20, p. 58]. Our hands were full—we had to hold our underdeveloped young, food, tools, and weapons. Our hands were busy—we had to gather food, hunt, and fabricate tools and weapons, not to mention perform the many other daily tasks that require the dexterity of the human hand. Second, using hand signals not only inconveniences the signer but also the beholder because the beholder must

withdraw his attention from what he is doing to see the signals. Third, hand gestures cannot be seen at great distances, at night, or in poor lighting. Fourth and finally, the speech code is more efficient than the visual code required by hand signals because “more items can be stored in a speech code” than in a visual code [21, p. 337]. Certainly speech evolved into a superlative mode of communication, but it came at a great price.

During the evolution of the speech apparatus, the roof of the pharynx became arched, and the tongue a more robust muscle. The shape and power of the mandible changed to favor speech over chewing, which required a concomitant change in diet. Our new mandible favored food that surrendered easily to smaller, less enamel-clad teeth, which meant less grain and more meat, the protein of which we needed to sustain our large brains. However, other biological changes had perilous consequences.

The larynx descended to make way for a larger pharyngeal cavity capable of the tremendous alterations in size and shape required by speech. Consequently, our sense of smell was reduced. The oral cavity could no longer be sealed from the rest of the airway during inspiration, a function that enhances the sense of smell. The airway bent to 90 degrees, increasing the resistance to air flow and decreasing the efficiency of respiration. And most consequential of all, the descent of the larynx introduced peril to the mundane task of eating—the potential for choking on food and liquids.

In *The Origin of Species*, Darwin pointed out “the strange fact that every particle of food and drink which we swallow has to pass over the orifice of the trachea, with some risk of falling into the lungs, notwithstanding the beautiful contrivance by which the glottis is closed” [22, p. 176]. The danger of choking threatened the survival of all people, except the infant, whose larynx does not descend until about the third month of life. In fact, “until the recent invention of the Heimlick maneuver, choking on food was the sixth leading cause of accidental death in the United States, claiming six thousand victims a year” [23, 1994, p. 354].

How could natural selection, which is supposed to ensure the survival of the species, introduce perils that can cause its extinction? Speech must have been an indispensable asset to man’s survival to be favored so aggressively by natural selection. For the *Neanderthal*, natural selection favored changes toward better chewing rather than a fully developed speech apparatus. Yet the *Neanderthal* is extinct. What Darwin calls “the inherited effects of use” must have given fast speakers a survival edge when *Homo sapiens* and *Neanderthal* co-existed [20, p. 57].

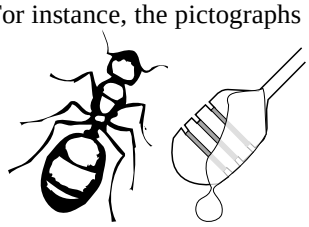
EARLY WRITING SYSTEMS

By the time the species known as *Homo sapiens* extrapolated the symbols of its linguistic brain to cave paintings some 30,000 years ago, “we can assume that the brain mechanisms that determine language [were] genetically transmitted” [18, p. 38]. By that time, our species probably had a hard-wired speech instinct. And although speech may have efficiently carried human thoughts from one head to another, it had its limitations as a vessel of *information*. According to Curtis Smith, information can be genetic, neural (memory), or cultural [19]. Although wholly responsible for the development of human language, genetic changes occur too slowly to carry new information from generation to generation. Neurological information stored in long-term memory is limited by individual capacity. Humans already have the highest brain-to-body ratio of any species on earth [18], but our brains can only get so big. In fact, the human brain is already so big that human babies are born extremely prematurely—compared to the rest of the animal kingdom—just so the baby’s head will fit through the birth canal.

Although the oral tradition accelerated the evolution of human culture—evidenced by the finely crafted stone implements of the Neolithic Age—speech is not considered a major source of cultural information. Smith defines cultural information as the result of modifying the physical world. An ax hewed from stone by *Homo habilis* and tossed aside after its use is a source of cultural information, even when exhumed a million years after its fabrication. Artifacts from generations long past can communicate to succeeding generations. Cultural artifacts are far more durable than the ephemeral modulations of human breath we call speech.

Humans overcame the limitations of genes and memory by inventing a system of symbols we call writing. Our first scribes used pictographs to graphically represent an object, idea, or action about 6,000 years ago [24]. However, a pictograph writing system could have thousands of icons, which would tax the memory of the scribe and the reader. Learning to write and read using pictographs could take dozens of years.

Users of the pictograph writing systems butted against another major problem time after time: How does a scribe express a proper name using pictographs? The solution was the first step toward an alphabet. To spell out a proper name, ancient scribes used a combination of pictographs that represented monosyllabic words. The solution is much like our present-day rebus game. For instance, the pictographs



are combined to produce “Anthony” (“ant honey”). The result of combining pictographs to express proper names resulted in a transitional writing system called a syllabary [1].

Syllabaries created by European scribes soon evolved into alphabets, which contained many of the original pictographs that now had an arbitrary association with elements of speech. The alphabet enabled scribes to represent spoken words by combining phonemic symbols. The relatively few characters of these early alphabets greatly facilitated the scribe’s work and the teaching of writing and reading. Moreover, because the new alphabet letters corresponded to the sounds of speech, the speech instinct fused inextricably with the reading process.

READING AND THE ORAL TRADITION

From the days of the first Sumerian tablets, written words “were meant to be pronounced out loud” [24, p. 45]. According to Alberto Manguel, “the primordial languages of the Bible—Aramaic and Hebrew—do not differentiate between the act of reading and the act of speaking; they name both with the same word” [24, p. 45]. The American psychologist Julian Jaynes claims that “reading in the third millennium B.C. may. . . have been a matter of *hearing* the cuneiform, that is, hallucinating the speech from looking at its picture-symbols, rather than visual reading of syllables in our sense” [25, p. 182]. In support of such a picture-to-speech notion, experimental investigations using native speakers of Chinese, who use ideographic writing systems, have demonstrated that during the silent reading of Chinese, the readers phonetically processed ideographs just as readers of alphabet systems phonetically process words [26, 27].

During the heyday of the Roman Empire, the bond between reading and the speech instinct was enforced by a highly literate culture. The text in Roman books and tablets contained no punctuation, no distinction between uppercase and lowercase letters, and, most importantly, no word separation. The Roman read aloud, syllable by syllable across the page, so that he could hear the syllables and therefore recover words and sentences from the speech stream. Because words were not separated by spaces, Romans had no clear concept of the written word as a unit of meaning [28, 29].

Even private correspondence was read aloud. Quintilian, the Roman rhetorician, claimed that reading everything aloud was a mnemonic tool, a way to retain the contents of a text. And, indeed, Roman composers intended for their texts to be read aloud. These composers wrote in rhythmic, metered prose like that heard in public orations. And composition itself was not a silent process. Composers would articulate phrases as they set them down

on wax tablets. Scribes in the scriptorium furiously wrote down words read aloud from master texts—syllable by syllable.

By the eighth century A.D., scribes in England and Ireland were dividing words because the sound of Latin, the language of the government, was foreign to the ears of the native population. Although no great portion of the population was able to read, those who could read needed to identify whole words upon sight because they were not familiar enough with spoken Latin to recover words from the speech stream [1]. The Saxon and Celtic priests were among those on the fringes of the Roman Empire with a weak grasp of Latin. They especially required word division to read liturgical texts aloud with the conviction of understanding. Attempting to read Latin texts without word divisions lead to embarrassing misreadings such as the words *collectam exilio pubem* ("a people gathered for exile") in Virgil's *Aeneid* being misread as *collectam ex Ilio pubem* ("a people gathered from Troy") [24, p. 48].

The practice of putting spaces between words, which slowly spread to the continent, is considered a major advance toward silent reading in the tenth century [28], although rare instances of silent reading predate this movement. In the fourth century BC, Alexander the Great silently reads a letter from his mother "to the bewilderment of his soldiers" [24, p. 43]. In 63 BC, Julius Caesar silently reads a "little billet-doux sent to him by Cato's own sister" [24, p. 43]. And in the fourth century AD, Saint Ambrose discovers Saint Augustine silently pouring over a text: "While reading, his eyes glanced over the pages, and his heart searched out the sense, but his voice and tongue were silent" [30, p. 110].

In the ninth century, the ability of scribes to copy texts word by word brought about regulations requiring silence in monastic scriptoriums. By the eleventh century, the silent copying of manuscripts was a normal part of monastic life. However, the most influential use of silent reading grew out of a new educational movement called scholasticism.

The development of a rigorous intellectual life in the twelfth and thirteenth centuries was facilitated by reading with the eyes alone. In this way, texts could be studied faster than by reading aloud. Volumes of religious and secular texts were devoured by students in the Cistercian abbeys and cathedral schools, from which universities would emerge. Libraries were designated quiet places for students to silently read texts. However, children still learned how to read aloud and did read aloud until they mastered reading.

By the end of the fourteenth century, texts composed silently were expected to be read silently. Punctuation was invented to aid the silent reader [28]. Whereas the oral reader usually read a text from beginning to end, paragraph and other marks helped the silent reader move around with itinerant eyes. Underlines indicated quotations, and periods enabled the division of a text into units now known as sentences.

The new punctuation marks were eagerly incorporated into texts by scribes who adopted a fifteenth-century invention, the printing press, which was introduced to England by William Caxton in 1476. Concurrent with the mass publication of texts, English speakers were changing the way they pronounced words in a movement called The Great Vowel Shift. As the printing presses functioned as de facto spelling authorities (and yet printers often purposefully misspelled words to justify lines of type), spelling-to-word correspondences were significantly altered. Words borrowed from Latin, German, Scandinavian, and French added new and confusing spelling-to-sound correspondences.

Despite massive efforts to reform English orthography from the mid-1500s to the early 1700s, spelling mirrored the whims of printers until fixed by lexicographers in the mid-1700s. Since that time, spoken and written English have changed relatively little. Moreover, the way modern children learn to read has changed little since the heyday of the Roman Empire, when the art of reading was conducted entirely through speech.

MODERN READING PEDAGOGY

Linguists call the first twelve years of human life the critical period, during which a child acquires and masters language [7]. This critical period begins with the babbling of an infant, an eruption of the hard-wired speech instinct. This great awakening occupies much of the infant's development. It listens for voices and speaks, crudely at first, but with increasing precision. In fact, "in the first weeks of life, a baby utters almost every sound of every known language" [31]. The baby slowly loses the ability to utter sounds not in the language of the people speaking around it. By experiencing the outside world, the baby associates sounds to meanings: objects in space such as /bottle/, abstractions such as /sad/, and actions such as /walk/.

After the baby has learned a basic spoken vocabulary, it learns the names of letters through the age-old tradition of repeating the letters as they are pointed out by its "nurse or mother in a hornbook or alphabet sheet" [24, p. 72]. In school, teachers use simple stories to relate the sounds mastered by the child to letters, and then sounds to groups of letters. The child thus masters phonics. By reading stories out loud, the child learns to recognize words by the way

they appear on the page and the way they sound when read. By the second or third grade, teachers urge the child to read silently by suppressing the speech instinct. In rare but certain efforts to suppress the speech instinct, grade school teachers have been known to go beyond kind instruction and tape the child's mouth shut, or make the child chew gum or suck on his fingers.

During the transition from learning-to-read to reading-to-learn, the child discovers that reading aloud—and indeed moving the lips at all—is socially unacceptable. The child has fully developed the automatic reading machinery, but is no more aware of it than he is aware of the electrochemical impulses coursing through his brain. He is not aware of the potent speech instinct that bears itself during silent reading throughout the child's life in the form of silent speech.

CONCLUSION

Silent speech—whether a product of current teaching practices, a vestige of our oral tradition, or an indivisible biological component of silent reading—enables readers to recognize words and hold them in short-term memory during the automatic reading process. It is indispensable in detecting errors during the revision process. The more difficult the reading material, the more readers rely upon silent speech to help them understand what they are reading. Today, more non-technical people are reading technical documents—from assembly instructions to software manuals to medical research articles—than ever before. Practitioners of technical communication will greatly benefit from using writing techniques based upon the role of silent speech in comprehending technical documents [16]. Educators should prepare their students for successful careers in communication by teaching them how to listen to what they write and edit.

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