

VIEWPOINT

THE VISION-AUDITION-CORTICAL VOCALIZATION CONNECTION IN READING

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Abstract

This viewpoint article is based on a literature review and clinical experience of the authors. They suggest that the role of inner speech is an important facet of the reading process. A dual-route model of decoding in reading is discussed. The authors propose that visual and auditory matching is necessary for cortical vocalization, a subtype of inner speech, to occur in the normal, as well as in the dyslexic, reading processes. Neurological and behavioral aspects are discussed as regards dyslexic subtypes.

Key Words

comprehension, cortical vocalization, dyseidetic, dyslexia, dysphonetic, inner speech, phonetic decoding, reading, sight-word recognition, subcortical vocalization

INTRODUCTION

Before learning to read, one must be able to comprehend the spoken language. After learning to speak, phonemic awareness can result. For example, the child can be taught that even a one-syllable spoken word, such as “CAT,” has three phonemic sounds, i.e., CUH and A (short as in bat) and TUH. This awareness prepares the child to learn to match vision with audition during phonological processing of phonemes, syllables, and whole words. In phonetic decoding of words, the letter sounds are blended into syllables and, in turn, the syllables are blended into a word. This also involves matching the auditory gestalts of phonemes and/or syllemes with the visual gestalt (composed of graphemes) of the word. This phonetic process is rudimentary; “decoding” is not limited to phonetic word attack. A more efficient method of matching vision and audition is eidetic whole-word decoding (i.e., sight-word recognition) from a stored memory lexicon.

Normal Reading Process

The weight of authority recognizes that audition is heavily involved in phonetic decoding (recognition) and encoding (spelling) of written words; however, we find that the role of auditory involvement in sight-word recognition is minimized in the literature. Note, however, that as you read this article silently, even without movement of lips, tongue, or vocal cords, you can “hear” in your mind each fixated and recognized word, almost

unconsciously at times. It is as though the recognized words are pronounced in your own voice. This kind of “voicing” can be exceedingly rapid, similar to the processing speed of a computer. The concept of inner speech was reported by Sokolov.¹ We propose a more descriptive term for inner speech in the reading process as *cortical vocalization*; this is to differentiate it from inner speech occurring when not reading, such as in meditation or other thought processes.

We use the term *subcortical vocalization* when there is movement of lips, tongue, or vocal cords that occurs when decoding is attempted. This may be done silently or with actual or simulated speech, such as mumbling the word when blending phonemes and syllemes (syllables). This behavior can be conceptualized as subvocal speech. This activity helps the individual “hear” the word to allow for cortical vocalization, so word recognition and comprehension of that word can result. The classic phonemic example of C-A-T exemplifies this processing in phonetic decoding, whether with phonemes or syllemes. It seems reasonable to suggest that Broca’s area would be heavily involved in subcortical vocalization, since that area is used for speech formation.²

The linguist, Leonard Bloomfield (quoted in Shaywitz³) stated that, “Writing is not language but merely a way of recording language by visible marks.” This suggests that the visual configuration of a word, which is made up of a series of

lines, circles, and squiggles, must be linguistically converted before it is interpreted for meaning. The written word, therefore, represents a sound, which represents an environmental object (noun or pronoun) or a linguistic description (e.g., beauty, going, thoughtful). As in listening, it would seem that cortical vocalization is necessary in reading before comprehension of the decoded word is achieved.

Fluent reading of sentences and paragraphs, however, is certainly more complex than recognizing single words, either phonetically or eidetically. Use of decoding is a “bottom-up” approach and is only one component in the act of reading. A deficit in decoding, however, is at the heart of the dyslexic reading problem. Keep in mind that one does not need to decode every word in most reading tasks since the reader can visually scan to “skim” the text. The prerequisites for doing this are efficient visual skills and good visual-perceptual information processing.⁴⁻⁶ One can achieve “rapid reading” by using contextual analysis and, particularly, if there is prior knowledge of the subject to derive meaning of the passages. Use of such contextual analysis is a “top-down” approach. We propose that a deficit in single-word decoding, however, is at the heart of the dyslexic reading problem. Since optometrists provide care for dyslexic individuals, an explanation of single-word decoding is important for understanding dyslexia.

A Review of Several Models of the Reading Process and Dyslexia

There are many reading theorists who propose a dual-route model of reading consistent with phonetic and eidetic decoding.^{3,7-19} Similarly, both the literature⁷⁻¹¹ and our clinical experience have demonstrated that there are two corresponding subtypes of dyslexia: dysphonetic (problem with phonics, syllabication and structural analysis) and dyseidetic (problem with visual whole-word recognition and recall). Interestingly, these models of the reading process and/or dyslexia rarely mention cortical vocalization.

Proverbio et al.¹⁸ implied inner speech by suggesting the dual-route model of reading associated with deficits in “phonological” and “surface” dyslexia, but noted that there is lack of consensus as to

the brain structures involved in word processing. Stein¹⁹ reported that reading of words requires two kinds of analyses: visual processing of familiar words and the use of inner speech for unfamiliar words, as in phonetic decoding. The assumption seems to be that there is no cortical vocalization in eidetic decoding of words as evidenced by the following statement by Stein¹⁹ *Their orthography yields the meaning of familiar words very rapidly without needing to sound them out.* Shaywitz³ proposed that there are two basic subtypes of dyslexia (“word analysis” and “word form”). These are representative of dysphonia and dyseidetic, respectively. However, Shaywitz neglected the role of cortical vocalization in “word form” dyslexia and contended that all recognition and meaning of a word takes place in an occipito-temporal cortical area; the role of Wernicke’s area was not included. Support, however, was made indirectly by Abramson and Goldinger²⁰ for the concept of cortical vocalization in eidetic word recognition: *The data suggest that acoustic representations activated in silent reading are best characterized as inner speech rather than as abstract phonological codes.* Interestingly, Flavell et al.²¹ found that preschool children have little awareness of inner speech but they usually acquire it during early school years through experience while reading, writing, adding, and subtracting. Again, note that as you read this article silently, even without movement of lips, tongue, or vocal cords, you can “hear” each word in your mind, although almost unconsciously. It is as though the recognized words are pronounced in your own voice. Mostly, however, you are unaware of this matching of vision and audition since this kind of “voicing” can be exceedingly rapid, similar to the processing speed of a computer..

Dyslexic Reading Process

The plethora of research in the field of reading, notwithstanding, there remains controversy as to the reading process in dyslexia. Dual routes in dyslexia are suggested,^{3,18-19} but there is lack of consensus as to the brain structures involved in word processing as well as with the concept of cortical vocalization.

We propose that cortical vocalization is essential in the act of reading; however, this is not as obvious in eidetic decoding

of whole words as it is in phonetic decoding with phonemes and syllables. It is probable that cortical vocalization results when a visual gestalt of the whole word is matched with the auditory gestalt of the whole word. A visual gestalt is a physiological unit, or “packet,” of graphemes, while an auditory gestalt is a physiological unit, or “packet,” of phonemes. When these two units are interfaced, possibly in the angular gyrus, cortical vocalization results, and the “sound” is comprehended in Wernicke’s area, where comprehension would similarly occur when listening to a speaker. Wernicke’s auditory area must be involved in comprehension of either a spoken word or a written word.^{2,22-25}

Connecting Vision, Audition and Cortical Vocalization in Dyslexia

We propose that both dyseidetic (sometimes referred to as lexical, surface, word form, or visual) and dysphonetic (sometimes referred to as auditory, phonological, or word analysis) subtypes of dyslexia involve vision and audition. Because vision is also involved in dysphonetic dyslexia, it is scientifically inaccurate (although in lay terms acceptable) to refer to it simply as “auditory” dyslexia. Similarly, because audition is involved in dyseidetic dyslexia, it is scientifically inaccurate (although in lay terms acceptable) to refer to it simply as “visual” dyslexia. Due to failure to match visual and auditory gestalts of whole words, a dyseidetic individual may rely on subcortical vocalization to achieve cortical vocalization for meaning of a word. Conversely, a dysphonetic individual may rely on visual processing so that a whole-word visual gestalt can be processed quickly and matched with an auditory gestalt. Cortical vocalization, therefore, takes into account both phonological and visual processing. This involvement occurs in relative degrees, depending on the necessities of individuals with each subtype of dyslexia.

A disruption at the level of decoding prevents correct cortical vocalization, which results in poor word recognition, which then affects comprehension. (See Figure 1.) Shaywitz³ suggested that such “blockage” is the essence of the problem of dyslexia. We agree with this concept.

As compensation, a dyslexic individual may use “filling in” of words from context to derive meaning. This strategy

