

BRINGING READING RESEARCH TO LIFE

Edited by

MARGARET G. McKEOWN
LINDA KUCAN

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DECODING, VOCABULARY, AND COMPREHENSION

The Golden Triangle of Reading Skill

Charles Perfetti

The triangle has presented a strong symbol through the ages, representing ideas in religion, astrology, and sexual identity, as well as more specialized denotations. For example, in mathematics it is the symbol for a small difference, and on the dashboards of modern cars, the symbol for warning and emergency. Naturally, reading has its triangle as well: Triangle models of word identification represent the three constituents of written-word knowledge—graphic form (spelling), phonological form (pronunciation), and semantics (meaning). Triangle models generally denote the class of connectionist reading models (Seidenberg & McClelland, 1989) but, more specifically, versions of these models that exert a semantic influence on word identification (Harm & Seidenberg, 1999; Plaut, McClelland, Seidenberg, & Patterson, 1996).

THE DVC TRIANGLE

Given the prolific spread of triangle imagery—and despite the established status of the triangle as a representation of written word identification—I think proposing a new triangle is easily justified. The DVC triangle is the interconnected set of cognitive-linguistic components that make up general reading skill: decoding, vocabulary, and compre-

hension. Each of these is a complex constituent rather than an elementary unit, so each has its own constituents. For example, the decoding constituent consists of orthographic and phonological knowledge; comprehension includes a wide range of basic sentence, extended text, and general-knowledge-based inference procedures; vocabulary includes both a quantitative (number of words) component and a qualitative (specific word knowledge) component. The complexity of the triangle is a matter of grain size—relatively fine or relatively coarse. For general descriptive purposes, the coarse grain size shown in Figure 15.1 is about right. It expresses the interconnections among decoding, vocabulary knowledge, and comprehension that are central to skilled reading.¹

The DVC model in Figure 15.1 is primarily a heuristic, suggesting a way to conceptualize reading skill (it is the triangle itself), while also illustrating causal relations among three critical constituents of reading skill (the sides of the triangle are directional arrows). Decoding leads to a word's meaning, but not to comprehension beyond the word directly. Comprehension affects vocabulary (word meanings are learned from context) but not decoding directly. And both the decoding–vocabulary and the vocabulary–comprehension relations are reciprocally causal.

Decoding–Vocabulary

Decoding affects vocabulary directly, because successful decoding events (1) retrieve meanings of familiar words, thus strengthening form–meaning connections, and (2) establish context-dependent links between unfamiliar words and meaning-bearing contexts. Vocabulary (knowledge of the meaning of a word) affects decoding because decoding a word whose meaning is known strengthens the connection between the word's orthographic form (its spelling) and its meaning. This process helps establish a word-specific representation, which is especially helpful for words with exceptional or irregular spelling–pronunciation mappings and theoretically helpful for all words, to some

¹ An important point in interpreting the triangle and in the discussion that follows is that a strict definition of decoding is the conversion of letter strings to phoneme strings. Word identification includes both decoding processes in this narrow sense and the retrieval of word-specific representations that uses knowledge about a word's spelling to identify it. In English, this word-specific process is needed for words whose spellings are exceptions to the dominant grapheme-to-phoneme mappings (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). A finer grained triangle model would be needed to distinguish these two identification processes.

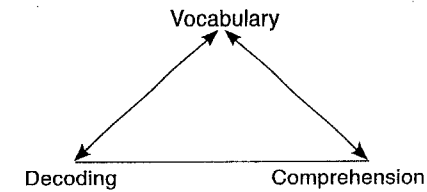


FIGURE 15.1. The DVC reading skill triangle. Abilities in decoding, vocabulary, and comprehension combine to produce general reading skill. Because the three constituents are interconnected, limitations in any one will affect at least one other constituent and will accordingly set a limit on overall skill. For some purposes decoding can be interpreted in its broad sense of word identification; for other purposes it is interpreted in its narrow sense of grapheme–phoneme conversion. (See Footnote 1.) These two would be differentiated in a finer grained triangle model.

extent. The importance of this meaning-to-form support is demonstrated by Nation and Snowling (1998), who found that word identification of comprehension-impaired readers was especially slow in identifying words that, theoretically, depend on frequent exposures (exception words). Simply put, as children decode words, they strengthen their vocabulary knowledge; and as children retrieve their knowledge of a word's meaning while decoding it, they strengthen the identifiability of that word.

Vocabulary–Comprehension

Comprehension is obviously dependent on knowing the meanings of words being read, and the DVC triangle represents this causal direction. At the moment a reader encounters a text, the ability to access the meaning of the word, as it applies in the context of this particular text, is critical. At the same time, achieving some comprehension from a segment of text that contains an unknown word also can cause the reader to learn something about the meaning of that word. Thus the causation runs both ways between word meaning and comprehension. That multiple causes can underlie the general correlation between vocabulary knowledge and comprehension has long been recognized (e.g., Anderson & Freebody, 1981; Beck, McKeown, & Omanson, 1987). Evidence for a reciprocal causation across measurement points, however, has come only recently from a longitudinal study by Wagner (2005).

Decoding–Comprehension?

The DVC triangle does not show causal arrows between decoding and comprehension in either direction. This is because the effects of decoding on comprehension are mediated by knowing the meaning of the decoded word. The effects of comprehension on decoding are mediated by achieving enough meaning from the text to verify the identity of a decoded word. Note that this assumption rests on the logic of cognitive event sequences in reading and not on correlations of skill assessments.

In practical terms, there is a strong causal relation between decoding and comprehension in that fluent or automatic decoding allows more processing resources to be available for comprehension (Perfetti, 1985). And comprehending a text aids word identification, especially for readers of low word reading skill (Perfetti, 1985; Stanovich, 1980). However, at closer distance, these causal effects depend on word meanings being produced by identification. Thus knowledge of word meanings (or vocabulary knowledge) has a pivotal position between word identification and comprehension (Perfetti, Landi, & Oakhill, 2005).

INDIVIDUAL DIFFERENCES IN LEXICAL QUALITY

The DVC triangle identifies possible differences in reading skill at each point of the triangle and also at the four causal links (two for decoding–vocabulary and two for vocabulary–comprehension). These seven possible sources of reading skill variability obviously are not all independent, and all have causal links to knowledge sources outside the triangle. For example, knowledge of word meanings is affected by pre-literacy exposure to vocabulary, which is stunningly variable across demographic categories (Hart & Risley, 1995). But it is simple enough to summarize key relations in reading skill:

1. Skill in reading comprehension will be affected by skill in decoding and skill in vocabulary (which will not be independent, according to the model).
2. Skill in vocabulary will be affected by skill in comprehension and skill in decoding (which will be independent).
3. Skill in decoding (understood as word identification) will be predicted by vocabulary knowledge.

Decoding skill itself supports self-teaching of written-word representations, which allows children to move from a reading process entirely dependent on phonological coding of printed word forms to a process that accesses words quickly based on their orthography (Share, 1995, 1999).

To clarify the omission of decoding–comprehension effects, note that assessments of decoding do correlate with assessments of comprehension (Perfetti, 1985), but on the present assumption this correlation reflects a causal connection from decoding to comprehension that is mediated by knowledge of word meanings. The decoding–comprehension correlation may also partly reflect their shared influences from outside the triangle (e.g., phonological knowledge, other linguistic knowledge, and general intelligence).

Beyond the more obvious implications for individual differences, there is an interesting, less obvious one. Children with weak decoding skills may have to depend more on the vocabulary → decoding side of the triangle. Indeed, a semantics-to-decoding connection helps to compensate for weak decoding skills (Snowling, Hulme, & Goulandris, 1994).

The DVC triangle representation of individual differences approximates that captured by the lexical quality hypothesis (LQH—Perfetti, 2007; Perfetti & Hart, 2001). The LQH claims that knowledge about word forms (phonological, orthographic, and morphemic knowledge) affects reading comprehension in both obvious and less obvious ways. The particular DVC of Figure 15.1, by collapsing distinctions between orthographic and phonological knowledge and between word identification and decoding, misses some important details in lexical quality but captures the broad relations.

To convert the triangle into a processing scheme, Figure 15.2 shows a linear flow of knowledge of word form and meaning to the processes of word identification and comprehension, with feedback from comprehension back to the word knowledge level.

According to the DVC and the LQH, word meanings are central to comprehension and word identification. However, research on comprehension has often ignored vocabulary to focus on other comprehension issues (e.g., inference making, comprehension strategies). Nevertheless, knowledge of word meanings cannot be ignored in accounts of individual differences. Meanwhile, the search for cognitive mechanism differences, as opposed to knowledge differences, has had the effect

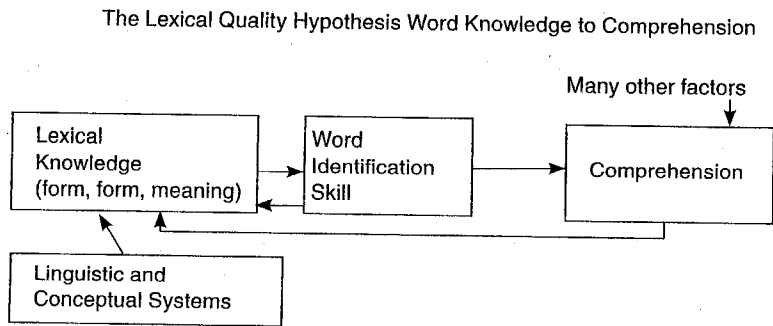


FIGURE 15.2. Simple schematic of the flow of information from knowledge about word form and meaning to comprehension through word identification. Lexical quality varies within the word-knowledge component and affects word identification and comprehension and is in turn modified by through both word identification (e.g., self-teaching) and comprehension (e.g., acquiring word meanings).

of suggesting that comprehension skill differences and knowledge differences (especially vocabulary) derive from differences in working memory resources (Daneman, 1988; Gathercole & Baddeley, 1989; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000). Cognitive resource differences cannot, however, explain the massive differences observable in exposure to language that builds the vocabulary children are likely to encounter in written texts (Hart & Risley, 1995). Somehow, and this is central to understanding reading comprehension, children both before and after the beginnings of literacy differ greatly in the numbers of words they know in both the sense of familiarity and specific semantic knowledge. (See Reichle and Perfetti, 2003, for a framework that links this distinction to lexical quality in a memory-based approach to recognizing words.) Such word knowledge is not only instrumental to comprehension but also a signature for literacy.

Although here I focus on word meaning as pivotal, I need to emphasize that word-form knowledge is also critical in skilled reading. The development of word reading skill depends on the refinement of word representations by adding spelling knowledge to spoken-word representations. This refinement produces representations that increase in *precision*, knowledge of all the letters of a word, and *redundancy*, complete letter knowledge and complete phonemic knowledge with con-

nections between the two. These characteristics allow word reading and meaning retrieval to be rapid and relatively automatic given a familiar printed word. Just as work on comprehension has sometimes ignored word meaning, research on word reading skill has tended to ignore spelling. We are learning, however, that even among “good readers,” differences in knowledge of word spellings lead to differences in word reading processes (Andrews, 2008).

THE DVC TRIANGLE IN THE CONTEXT OF THE READING EDUCATION FIELD

It is useful to ground the DVC triangle in two contexts relevant to reading research. The first places the triangle idea in a personal historical context. My approach to reading has been fairly simple, grounded on the idea that reading is a process built on language. The distinctive part of reading, in this commonsense view, is written-word identification: The singular recurring cognitive activity in reading is the identification of words and the retrieval of their meanings. From this it follows that comprehension depends in part on successful word reading and that skill differences in comprehension can arise from skill differences in word reading. This was not an easy thing to acknowledge. I came to reading from training as a psycholinguist. Naturally, I became interested in reading comprehension as a language problem and, along with my graduate students, considered where “the action” was in reading comprehension skill. Syntactic abilities? Getting meaning from sentences and paragraphs? Higher level language knowledge? Despite the inherent interest of these possibilities to a psycholinguist, I thought the first step was to ask about word reading and the role it played in comprehension.

These observations on the role of word identification in reading were the core of a theory of comprehension skill that, over 25 years ago, I referred to as *verbal efficiency theory* (Perfetti, 1985): Word identification, the rapid retrieval of a word’s phonology and meaning, was a limiting factor in comprehension. Verbal efficiency theory is the ancestor of the DVC triangle and the LQH and captures some of the same ideas.

I came to conclude, however, that verbal efficiency’s emphasis on general *processes*—decoding, phonological processes, retrieval, memory, automaticity—did not quite capture the importance of knowledge. Verbal efficiency implied that skilled reading was about efficient pro-

cessing mechanisms and that less-skilled reading was about these same mechanisms operating less efficiently. But where did differences in efficiency arise? Although differences in processing capacity provide a possible answer to this question, it did not seem plausible as the whole story. Skill differences were often specific to reading, and they were subject to practice effects. Instead, I concluded that the major source of reading ability is the knowledge a reader has about words, specific lexical representations. Knowledge plus practice that refines the knowledge and makes it more accessible leads to efficient processing. This perspective on the problem led eventually to the LQH (Perfetti, 2007; Perfetti & Hart, 2001). Although the lexical knowledge emphasis was an important refinement of the verbal efficiency hypothesis, this emphasis was already anticipated in *Reading Ability* (Perfetti, 1985), which has several observations that emphasized knowledge rather than process. For example, I argued in that volume that the retrieval of a lexical representation is high in quality "to the extent that it contains both semantic and phonetic information sufficient to recover its memory location. ... This quality must be retained long enough for subsequent processes to perform their work. Thus a 'name' without meaning and a meaning without a 'name' are both low quality" (Perfetti, 1985, p. 118).

The second context for the DVC is that it aligns well with the research of Isabel Beck. Indeed, it is remarkable that the whole of the triangle can be instantiated by the research career of Beck and her colleagues. Next, I consider each point of the triangle in turn.

Decoding

First, Beck's early work developing code-based reading instruction (Beck & McCaslin, 1978) sits at the decoding corner of the triangle. Her approach to decoding followed the foundational principles of alphabetic reading by directly teaching the correspondences between letters and phonemes. Its distinctive addition to this basic principle was a procedure to support blending, the integration of phonemes so that the child would learn to map letter sequences to phonological words (m-a-t → /mæt/) rather than only to isolated phonemes (m → /m/; a → /æ/; t → /t/). The basic good sense of this program, as well as its careful optimizing aspects, flew against the wind of the whole-language movement. Much later, with the return of good sense to the teaching of reading, Beck's *Making Sense of Phonics* (2006) reestablished the value of decoding instruction for a more receptive practice community.

Vocabulary

At the vocabulary corner of the triangle, the story is similar to the decoding story. Direct instruction in decoding was not in vogue at the time that Beck developed a direct instruction program, and neither was direct instruction in vocabulary, although for a different reason. Although no one argued against the value of direct instruction of vocabulary, little instruction actually occurred in schools (Scott, Jamieson, & Asselin, 2003). People generally assumed that such instruction was of marginal value, because most word learning occurs incidentally through reading and spoken-language experience. For example, Nagy and Herman (1987) estimated that vocabulary might grow by 2,000 to 3,000 words per year over grades 1–12. Thus, at best, direct instruction might help children learn a tiny percentage of the massive English vocabulary needed for academic success. I believe this observation is correct as far as it goes. But it does not take into account some important additional considerations. First are the massive individual differences that are present in vocabulary knowledge in school-age children, especially differences across different socioeconomic classes, that arise well before children enter school (Hart & Risley, 1995). If one could teach 100 words to a child who knows only 2,000 academically useful words (a possible estimate for a child entering first grade from a very low socioeconomic status [SES] background), the result would be a noticeable 5% gain. Even at 4,000 (2.5%) or 8,000 words (1.25%), it is not clear why one would want to dismiss the gains to vocabulary, except for issues of allotting instructional time. Second is the potential for vocabulary "spread." Words related to the meaning of a new word can be used in connection with the new word, and Beck and colleagues' robust vocabulary instruction (Beck, McKeown & Kucan, 2002) promotes high levels of verbal interaction around a taught word, inevitably strengthening the use of other words and the concepts underlying them. Third is the potential for enhancing a child's lexical awareness, that is, an increased attention to words, their meaning similarities, their differences, and perhaps even their forms. Part of this increased awareness depends on becoming interested in words and engaged in academic language production, as well as comprehension. Although it remains to be seen whether robust vocabulary instruction produces such gains, it is clear that this instruction, as developed by Isabel Beck and her colleagues, includes the kinds of meaningful engagement with language that could promote them.

Comprehension

"Comprehension" covers a lot of territory in reading, and the practical issues have tended to localize on a very broad part of it, the higher level comprehension ability to understand extended written texts, as indicated through answering questions, recalling, or summarizing stories. Beck and McKeown (2006) developed Questioning the Author as a way of guiding teachers to support what they saw as the critical component of comprehension: attention to the meaning of the text. As in Beck's other work, this idea is a blend of common sense with research and theory. Getting meaning from a text is about reading the words, encoding their meanings, using sentence structure to form their meanings into semantic content (e.g., propositions), and integrating these meanings with "prior" knowledge and across sentences (Kintsch, 1988; Perfetti, 1985). On this view, the central strategy for reading comprehension is to answer the question of, What does the text say? Other questions (including *why* questions) engage the reader with the content with the goal of supporting a text-based mental representation of the text. This content-based strategy may be more effective than strategies that aim at a general level (e.g., making inferences, monitoring for confusions) that only indirectly engage semantic content (McKeown, Beck, & Blake, in press).

THE COMPREHENSION-VOCABULARY LEG OF THE TRIANGLE

As I noted earlier, comprehension covers a large territory, and educational research in comprehension has attended more to the higher level part of this territory. But comprehension is also about understanding sentences through the meanings of the words they contain—local processes as opposed to global processes. I was able to join Beck, McKeown, and colleagues some years ago in studies that exemplify this level of comprehension and, more important, the link between word meanings and local comprehension. Beck, Perfetti, and McKeown (1982) instructed children in vocabulary and then inserted the newly learned words into sentences and measured the reading (sentence verification) times on the sentences. Children showed gains not only in word meaning measures but also on sentence verification when the sentences contained newly taught words. McKeown, Beck, Omanson, and Perfetti (1983) later found comprehension gains for passages following vocabu-

lary training. Comprehension of texts allows readers to add new word meanings to their vocabularies, and learning new word meanings allows readers to comprehend texts that contain those words.

CONCLUSION

The DVC triangle reflects the interdependence of knowledge about word forms (decoding and word identification) and word meanings (vocabulary) and comprehension processes. The LQH formulates these dependencies in terms of the components of word knowledge and its consequences for comprehension. In this framework, once beginning reading—decoding—has been mastered, reading depends on a complex of acquired skills honed by effective reading experiences. Experiences that yield comprehension and also strengthen knowledge of word forms and meanings essentially provide practice for reading skill.

Research has contributed substantial knowledge that is of value for reading instruction. We know how to support instruction in decoding so that children can acquire the foundation point of the reading triangle. We are equally sure about the importance of vocabulary but less clear about how to ensure that it keeps up with demands of academic learning. Unlike decoding, which is the great equalizer for unequal opportunity, vocabulary is the reflection of unequal opportunity. Accordingly, it is an even bigger problem to tackle, although we do know how to help children learn word meanings. Comprehension would appear to be the biggest problem, but the research field has provided some useful guidance for comprehension instruction. Once we take into account the vocabulary-comprehension connection, the comprehension issue shrinks a bit. Being able to identify words and use their meanings is a large part of the issue, and with reading practice, especially effective text reading, to support knowledge of word forms and meanings, the comprehension issue becomes one of general language comprehension, certainly a big issue in itself.

Because the problems are specialized, researchers typically have pursued one or other corners of the triangle—justifiably so, because each corner represents complexity well beyond what I have implied here. For several reasons, I have found myself working on all the corners and legs of the triangle at one time or another and sometimes at the same time. Truly impressive, however, is what Isabel Beck has done in this triangle. Beyond experimental research, she and her colleagues have taken on the hard problems of instruction, at not one or two but

all three points of the triangle. The result is three different projects of systematic, research-based interventions that help students to decode, to learn word meanings, and to comprehend.

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