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REDUNDANCY AND READABILITY

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As the chemist trains a full array of analytical instruments and processes on an unknown solution to learn its properties, so too must the language/communication "scientist" bring a variety of theories and tests to bear upon the only partly understood concept of readability. Defined as what makes a text easy or hard to read, readability is somewhat like the unknown solution: a few elements are easily found with simple and superficial tests, but its major components remain elusive. The text and the reader as central determinants of readability have recently become more accessible to analysis as a result of the findings of research on redundancy, the natural overlap of information in language, and on propositional analysis, a strategy for analyzing meaning in a text. Both redundancy and propositional analysis help to reveal the nature of text-reader interaction, and are therefore two of the important missing elements in readability.

Redundancy is, in itself something of an unknown quantity, and a number of researchers have been experimenting on it (Horning, 1979). Several years ago, H. J. Hsia, a Texas Tech communications theorist, clarified several different types of redundancy, providing important insights into the ways in which these different types of redundancy contribute to readability (Hsia, 1977). Hsia's research helps to isolate some of the unknown elements in readability, and these elements look as if they have the potential to bond neatly to the textual analysis system proposed in great detail by Walter Kintsch of the University of Colorado (Kintsch, 1974). Propositional analysis provides a system for objectively analyzing meaning in a text, and may yield a measure of the properties of redundancy described by Hsia. If so, the result will be a much purer analysis of the nature of readability.

Professor Hsia claims, in his analysis, that redundancy enhances communication and is essential to it. This dimension of redundancy makes it important to readability: readable texts communicate to readers, whereas unreadable ones do not. Hsia discusses three major types of redundancy: redundancy within a communication channel, redundancy between two or more channels, and input-memory redundancy. Each type of redundancy facilitates communication, and by implication increases readability.

In within-channel redundancy, all of the information goes from the sender to the receiver through one mode or channel; in the case

of reading, readers use the visual channel. In this channel, the redundancy of the language of the text lies in its syntax, its semantics, and its pragmatics. These three aspects of language overlap with one another and provide a reader with more than one way of getting a given piece of information from the text.

Certain aspects of language-related redundancy have already been investigated. Psychologists (Garner, 1962), linguists (Cherry, 1966) and information theorists (Hsia, 1977) have, for example, conducted detailed studies of the syntactic redundancy of language. Syntactic redundancy is pretty obvious, fixed and easy to measure. A simple sentence illustrates syntactic redundancy: "The boys were eating their lunches." The information that the subject is plural is conveyed by the *-s* ending on the subject, the plural form of the verb, and by the plural form of the pronoun. Syntactic structure and markers provide several ways of getting the information that the subject is plural. This redundancy contributes to reading insofar as it is naturally present in the text and permits readers to get the text's message efficiently.

Unlike syntactic redundancy, semantic and pragmatic redundancy are quite difficult to define and to measure. The problem lies in the lack, until recently, of an adequate means of analyzing semantic aspects of text, especially larger units of discourse above the sentence. Pragmatics still presents a major challenge in this regard, but semantic analyses of the propositional content of texts make meaning far more accessible and measurable now (Lachman, et al, 1979). One such system of propositional analysis is that proposed by Walter Kintsch (1974). Kintsch recognizes the implications of his system of analysis for reading, and has recently begun to write articles addressed to those concerned with reading (Kintsch and Vipond, 1979; Kintsch, 1979). His work helps with readability because it has the potential to isolate and measure the semantic, and perhaps the pragmatic elements of within-channel redundancy, and may contribute to the measurement of input-memory redundancy as well.

Kintsch's psychological research in the area of memory deals with the way people store the meaning of a text and the way they recall it. He offers propositions as the elements which represent the meaning of language in the human brain. Propositions, he says, can be analyzed. Propositions are composed of word concepts, which are abstractions realized in language by words or phrases. Word concepts are written in capital letters in Kintsch's articles, to avoid confusing them with words. The first word concept in a proposition is a relation, and the others are called arguments. An ordered list of these propositions comprise a text base, a representation of the meaning of a whole unit of discourse such as a sentence. Kintsch's studies attempt to validate propositions as meaning units, to show how they are related to standard English prose, and how they affect the shape that meaning takes in human memory. Kintsch often asks his subjects to read a passage and write down what they recall from it, and this format suggests the applicability of his findings to reading and readability.

An example will help to clarify propositional analysis. In one study, Kintsch asked subjects to read the following sentence:

"Romulus, the legendary founder of Rome, took the women of the Sabine by force" (Kintsch and Keenan, 1973). This sentence was constructed from the following ordered list of propositions:

1. TOOK, ROMULUS, WOMEN, BY FORCE
2. FOUND, ROMULUS, ROME
3. LEGENDARY, ROMULUS
4. SABINE, WOMEN

This ordered list of propositions, or text base, provides an abstract representation of the meaning of the sentence. Analyses of longer units of discourse, such as a paragraph or whole essay, can be conducted using this system of analysis, which has been worked out in some detail (Turner and Greene, 1977).

Kintsch's research using propositional analysis suggests several interesting properties of readability. Some of his studies have suggested, for instance, that certain types of propositions make a text easier to read than others, and that certain types of propositions are more likely to be recalled than others. For example, in the Romulus sentence, readers are more likely to recall the first proposition, which is the superordinate proposition in the list, than they are to recall the others, which are subordinate. There are specific and technical definitions for super- and subordinate propositions which need not concern us here.

The key virtue of propositional analysis for redundancy and readability is that it provides an objective system for analyzing the meaning of a text, and therefore, has the potential to give us a method of measuring semantic, and perhaps also pragmatic redundancy levels in a text. So, for instance, it might be possible to say that semantic redundancy is created when the same argument appears twice in a text base, either within a single proposition or in two successive propositions. Much work lies ahead, but an entire line of investigation is now available through the use of propositional analysis.

There are several reasons why this very promising work has not yet been done, and why we are not reporting such research instead of musing about it. First, the elements of propositional analysis are not yet fully understood. Scholars in memory theory (Anderson, 1976; Clark and Clark, 1977) and in artificial intelligence (Lachman, et al, 1979) have criticized Kintsch's research methodology and his conclusion about meaning and memory drawn from the studies he has done. Second, one incurs considerable difficulty with the system when one attempts to apply propositional analysis in a practical situation. Furthermore, other systems of propositional analysis are similarly complex and difficult to use in research without benefit of special training (Fredericksen, 1975 and 1979). Thus, findings by Kintsch need to be replicated, and additional work must be done to make the system of propositional analysis more accessible for readability research. Even Kintsch's sharpest critics agree, however, that propositional analysis studies are quite suggestive of a relationship between meaning and propositions, and this consensus supports propositional elements as key components in readability.

Additional insights concerning readability derive from a second type of redundancy called between channel redundancy by Hsia, which

occurs when the same information is conveyed by two different channels, such as auditory and visual. Redundancy between channels is created, for example, when readers look at a printed text while it is being read aloud to them. Hsia points out that where the information in the two channels is the same, communication is enhanced, and where it is completely different, there is not redundancy at all, and communication is lost.

Between channel redundancy is important chiefly in beginning reading, where it is often the case that readers are looking at a printed text while it is being read to them. In fact, Frank Smith (1978) points out that children learn to read in just this maximum redundancy situation: when beginning readers are read to—that is, when they are looking at a printed text and hearing it at the same time—they are actually learning to read. Fluent readers probably make only limited use of between channel redundancy, except when they are forced to, as is the case in a TV commercial, or in the special case of a very difficult text. Many college students have reported that they "read to themselves" when they don't understand what they are reading. The use of the dual channel creates additional redundancy, and as Hsia has claimed, increases communication and comprehension (Munsell, 1981).

H.J.Hsia's third type of redundancy is most interesting and most relevant both to certain aspects of propositional analysis and to readability. The third type of redundancy, called input-memory redundancy, Hsia defines as: "...the redundancy between the information being processed and the information within the memory system, which may conveniently be termed input-memory redundancy (IMR)... IMR is neither the redundancy among various kinds of information stored in the memory, nor the redundancy between memory and external information, which is infinite; IMR is simply the redundancy between input and memory... ..high IMR, it may be intuitively known, decreases the difficulty and increasing the comprehensibility of a communication (Hsia, 1977, p. 73)." The more readers know about the material they are reading, the higher the IMR will be, and the easier the text will be. In a common sense way, the concept of input-memory redundancy accounts for the fact that it is easier to read a novel than philosophy or linguistics, because in a novel, the IMR is undoubtedly much higher.

IMR is important to readability because it captures a notion that psycholinguists have been talking about in an intuitive way for some time. Frank Smith (1978) and Kenneth and Yetta Goodman (1979) have pointed out that a critical factor in reading ability is what the reader brings to the text, or what is usually referred to as prior knowledge. Prior knowledge naturally enhances the readability of a text because it creates input-memory redundancy. Prior knowledge is the memory part of IMR. But it is clear that prior knowledge, or input-memory redundancy, is just as difficult to define and measure as semantic and pragmatic redundancy, if not more so.

The insights on input-memory redundancy rely heavily on common sense and intuition, rather than on good empirical measures. One way of measuring it that might come to the reader's mind is Cloze procedure (Taylor, 1953) which Hsia mentions. Cloze tests, because

they ask the readers to complete the input with what they have stored in memory, seem to measure input-memory redundancy. Interestingly, Cloze tests have been used as a measure of readability—not surprising if they do indeed measure input-memory redundancy (Klare, 1974). However, Cloze tests are a kind of litmus paper measure of the performance aspect of IMR, and there is much more to IMR than what can be seen in performance. A corollary to Kintsch's propositional analysis potentially provides a much more detailed analysis of IMR.

In his more recent research, Kintsch has been formulating a model of text comprehension and text production, seeking a comprehensive analysis of human language processing. Like others, studying language processing from a global perspective (Tuinman, 1980), Kintsch has formulated the notion of a schema which he defines as:

a representation of a situation or of an event; it is a prototype or norm and specifies the usual sequence of events that is to be expected. Just like other concepts, schemata are fuzzy and imprecise (Kintsch, p.78).

A schema plays an important role in comprehension because it provides an outline of reader expectations into which the meaning of the text can be put. The schema is filled in by the propositions, described above, which represent the meaning of the text. Kintsch gives an example of a schema to clarify the term: the schema for a child's birthday party implies presents and guests. If a person was reading a story about a birthday party for a child, that schema would presumably be brought to bear on the reading. The reader could fill in an outline of expectations with what is actually given in the text. The schema may seem to be more a property of the text, and hence, to belong to within-channel redundancy, but in fact, schemata are generally conceived of as being partly in the text and partly in the reader. In Hsia's terms, the schema resides partly in the input, and partly in the reader's memory. Where input and memory rely on the same schema, redundancy exists and readability increases.

Many other researchers in reading and psychology have been investigating the use of a schema in reading comprehension (Tuinman, 1980). One of the more interesting studies contrasts the schemata for fiction and non-fiction prose (Olson, et al, 1981), and begins to reveal their importance in readability. Olson and his colleagues found that readers rely heavily on their schemata for stories and essays as a base for comprehension, and that readers use a different schema for each of these genres. Thus, not only can the varying types of schemata that readers use be specified, but their function in comprehension is becoming clear:

The basic orientation of the reader of a story is prospective. The reader is looking ahead, trying to anticipate where the story is going. Except at the beginning, where an overall hypothesis is being developed, the story reader tends to relate each sentence to the general hypotheses and predictions that have been developed. In contrast to this, the reader of the essay appears to adopt a retrospective orientation. Each new element in the essay is related to earlier elements. There is little anticipation of what is coming up, except at the most general level. This

difference in orientation on the part of the reader is of course due to the basic difference in underlying structure of these two genres (Olson et al, 1981, p. 39).

Genre-related schemata, then, play an important role in reading comprehension; they are not only part of the essence of the text, per se, but also, they are quite specifically part of what readers have stored in their memory, and they contribute to input-memory redundancy and so facilitate comprehension.

Those factors that facilitate comprehension are the missing and elusive elements in readability, and the types of redundancy and propositional analysis are two of those factors. Redundancy and propositional analysis are elements bound to readability in locations suggested by Kintsch:

readability is not somehow a property of texts, but it is the result of the interaction between a particular text (with its text characteristics) and particular readers (with their information-processing characteristics) (Kintsch & Vipond, 1979, p. 43).

To get a picture of readability, then, both the text and the readers must be analyzed. The text can be analyzed, as suggested here, for within-channel redundancy. Semantic aspects of within-channel redundancy can be analyzed and measured in an objective fashion with the use of propositional analysis. The text can also be analyzed insofar as it provides the input part of input-memory redundancy. Input-memory redundancy addresses the readers and what they bring to the text in the form of schemata. Schemata create input-memory redundancy between the reader and the text, playing a clear role in facilitating comprehension, and so, are themselves important elements of readability. These various elements may have to be spun in the centrifuge and inspected many times before they are fully understood, but the potential for achieving a complete analysis of readability, thanks to Professors Hsia and Kintsch, is now quite strong.

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