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THE INTERACTION OF COGNITIVE ISSUES AND THE READING PROCESS*

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RESUMO

*O trabalho considera alguns aspectos teóri-
cos da psicologia cognitiva vistos como importan-
tes para uma melhor compreensão do processo de
leitura.*

*Partindo-se de uma visão de compreensão co-
mo um processo interativo, primeiro discute-se
como a informação nova é processada, para, em se-
guida, enfatizar-se o papel desempenhado pelo co-
nhecimento prévio, resultado de nossa experiên-
cia de mundo.*

1. PRELIMINARY REMARKS

The main purpose of this paper is to bring together some theoretical issues in cognitive psychology which are of importance to an understanding of the reading process and, consequently, of special relevance to the teaching of reading. This theoretical background informs the view this paper adopts of comprehension as an interactive process which involves both text-presented material and the information the reader brings to the reading task in the form of previous knowledge. This

paper will first discuss how new information is processed, that is, how the flow of information is perceived, how it comes into our brains, how it is fully processed, and how it is stored for future use. Next it will stress that previous knowledge, which is the result of our experience in the world, plays a fundamental role in our everyday processing of information.

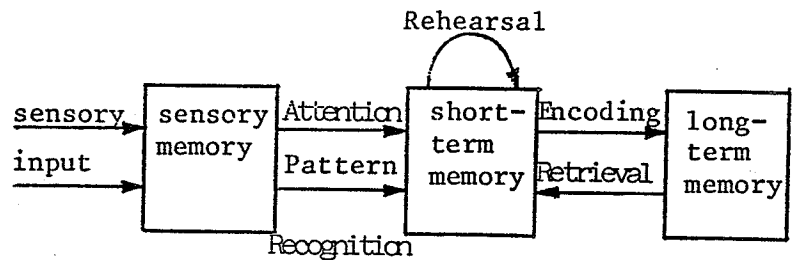
The view of comprehension as an interactive process implies that comprehension is not an effortless task—the reader cannot just wait for meaning to reach him, he has actively to construct the correct interpretation of what he is reading by making use of all linguistic and nonlinguistic guides provided by the written text itself and also by retrieving the adequate background knowledge he already possesses and which is necessary to comprehension. This means that in his task of constructing meaning the reader is not only guided by what he reads, but also by what he expects to find in a written passage based on previous knowledge and contextual clues*.

In processing written material for comprehension, the reader derives the meaning his previous knowledge enables him to. This may explain text polysemy—a piece of written material is not understood in the same way by two individuals: how, what, and how much something is comprehended is largely dependent on each individual's preexisting knowledge that is brought to interact with the information conveyed by the text itself.

Let me then proceed with a brief discussion of the theoretical issues, namely, the information-processing system and the concept of schema and relate them to the reading process.

2. THE INFORMATION-PROCESSING SYSTEM

Cognitive psychologists have concentrated a great deal of research on the way information is taken in, selected, processed and encoded. One of their main concerns is the study of the various processes undergone by the flow of information from the moment it is received to its comprehension and retention. The following diagram schematically illustrates the sequential tracing of information from environmental stimuli to long-term memory*.



As the arrows above indicate, the processing of information occurs mostly from left to right in the following way: environmental stimulus enters sensory memory which holds information for a very short period of time; then the processes of attention and pattern recognition come into play in order to select and identify some of the information held by sensory memory for a more detailed processing in short-term memory; finally, information that has just come into short-term memory and information that is retrieved from long-term memory interact in short-term memory and processing, encoding, and transfer to long-term memory take place.

It is important to point out that material remains in short-term memory for a very short period of time (15-30 seconds) unless it goes on being processed in some way. Thus, material may be retained in short-term memory through "rehearsal", that is, a deliberate allocation of attention to a specific item we are thinking about now as, for example, when repeating a telephone number while dialing the phone. Material may also be retained in short-term memory while it is being processed before encoding in long-term memory. As Harris (Chapter 7:28) explains, "if material is actively attended to, rehearsed, or otherwise thought about, it can remain in short-term memory indefinitely."

A basic paradox which involves this kind of model for the information-processing system must be pointed out here. Though the flow of information proceeds mostly from left to right, sometimes material has to be retrieved right to left from long-term memory. This occurs because we have to rely on the knowledge already stored to process and comprehend new information. This need to retrieve information from long-term memory occurs at different points: either earlier at the perception stage when attention and pattern recognition processes are taking place or later at the moment of the interaction between new information and information activated from long-term memory in short-term store.

While information is being processed, top-down (conceptually-driven) and bottom-up (data-driven) processes are taking place simultaneously. "Bottom-up processes refer to the processing of the environmental stimuli themselves" while top-down processes involve "expectations about what the data will hold, based on past experiences

and knowledge in long-term memory. "(Harris Chapter 7:4).

It might be appropriate to provide some further information about each store of memory, namely, sensory memory, short-term memory, and long-term memory. Let me then proceed with a more detailed description of them.

Sensory memory is "the most immediate and perceptual store of memory." The primary function of this type of memory is simply to hold new incoming information for a very brief span of time. Information held in sensory memory is "selectively attended to and identified for further processing in short-term memory." Information that is not selected for further processing decays very quickly from sensory memory. (Harris Chapter 7:5).

Short-term memory is the store of memory which "contains all the information that we are thinking about right now." (Harris Chapter 7:27). This includes both information retrieved from long-term memory and new incoming stimuli. As mentioned before, material which is neither maintained in a state of activation nor sent to long-term memory for a permanent storage decays very rapidly from short-term memory. It is worth noting that information can only be used if in this active state. As Anderson (1980:169) puts it, "STM [short-term memory] serves as a repository for knowledge that is required by cognitive processes being performed. These procedures cannot function if the knowledge is not in STM."

A point must be made about the limited capacity of short-term memory. Research has provided evidence that this store of memory can hold up to six or seven items at one time; thus, as Harris points out, it can hold seven numbers, also seven words, seven pictures, or even seven

sentences. However, we can overcome the limitations of short-term memory by organizing "small detail into larger units." This organization is known as "chunking". (Smith 1981:40) Harris explains that by making use of "chunking" we may combine larger pieces of information together to make them occupy less space in short-term memory. He provides the following example: we may chunk "the three words, rabbit, hat, and hamburger, from three bits into one by encoding them as one coherent image of a rabbit wearing a baseball cap and chomping on a Big Mac." (Harris Chapter 7:29).

Long-term memory refers to the part of memory whose primary function is to store all our knowledge. Unlike short-term memory, it has an unlimited capacity and keeps information indefinitely. Smith (1981:43) points out that the basic difference between short-term memory and long-term memory is related to "one important word—organization." While the former holds unrelated items, the latter is "a network, a structure of knowledge, it is coherent."

The discussion just provided about the information-processing system is extremely relevant to an understanding of the processes involved in the comprehension of a written text. It makes it clear that comprehension is a very complex activity which involves a series of processes and cognitive abilities on the part of the comprehender. It also makes it clear that comprehension occurs gradually, involving intermediate processes which are of crucial importance to the final goal of the comprehender, that is, the understanding of what he reads.

At this point let me relate this body of theoretical information to the reading situation. Suppose a reader has, among the different

reading situations he might encounter, three texts dealing respectively with, say, biology, computer science, and politics. The visual information conveyed by the texts—letters, illustrations, divisions between the paragraphs, punctuation, etc.—is registered by the reader's most immediate and perceptual store of memory: the sensory memory; it then holds information just long enough in order for it to be selectively attended to and identified by means of the two early processes in the sequence of the processing of information: attention and pattern recognition.

Let us suppose that this particular reader chooses to attend to the text on computer science; he then allocates more attention to that text and his choice is based not only on the information in sensory memory but also on information retrieved from his long-term memory. Perception is not a passive grasping of external stimuli, it is, rather, an interaction in which new incoming stimuli are selected and associated with the knowledge of the world the individual already possesses stored in his long-term memory. Thus, it is likely that one of the reasons for this reader to choose the text on computer science is that he probably has more information about computers in his long-term memory.

Therefore, after using his processing capacity in order to select which text to attend to, this specific reader starts analyzing and identifying its components as exemplars of concepts he already possesses stored in his own memory by the use of processes of pattern recognition. All information is then sent to short-term memory where the real processing of the information conveyed by the text takes place.

Then, the final stage is the detailed processing of information, its encoding and transfer to long-term memory. While information is being processed, already stored knowledge is again retrieved from long-term memory since comprehension only takes place when there is an interaction between incoming new information and the reader's preexisting knowledge. At this point the reader thinks about what he is reading, he judges the validity of the message, he compares what he is reading with knowledge retrieved from long-term memory, he infers from what he is reading—the slots left by the text are filled by his previous knowledge.

While the reader is actively involved in his task of comprehending what he reads, he bases himself not only on the linguistic guides provided by the text, but also on the knowledge of the world he already has. As pointed out earlier, comprehension results from the essential interplay of top-down and bottom-up processes. The reader not only brings knowledge to the comprehension task based on what he already knows, but also makes use of the explicit information conveyed by the text, the redundancy of language, and so on in his dynamic interaction with the text he is reading.

The information about computers while actively processed remains in the reader's short-term memory. After its processing and comprehension it is encoded in long-term memory for future use. (Information which has not been processed decays from short-term memory and is forgotten). Both processes—encoding and retrieval—occur simultaneously when the reader is interpreting his chosen text: he encodes material for future use and he also retrieves

information from long-term memory to make it possible the required interaction between his preexisting knowledge and new incoming information in his active involvement with the construction of the meaning of the text he is reading. Comprehension does not lie exclusively in either the text or the reader, but in the interaction between both.

3. THE CONCEPT OF SCHEMA

Let me now turn the focus of attention to the concept of schema (plural schemata or schemas) relating it to the reading process. Cognitive psychology provides evidence that schemata play an important role in how we process written materials. As pointed out earlier, the process of comprehending new information involves us in making use of our schemas, that is, units of generalized knowledge we have stored in our long-term memories. These units are in fact the fundamental elements all information processing depends on. Rumelhart (1980:33-34) points out that

Schemata are employed in the process of interpreting sensory data (both linguistic and nonlinguistic), in retrieving information from memory, in organizing actions, in determining goals and subgoals, in allocating resources, and, generally in guiding the flow of processing in the system.

One important characteristic of schemas or schemata is that they have slots or variables. These slots are filled with different specific information when the schema is activated. The process of filling these slots is called the instantiation of the schema.

A second major characteristic of schemas is that they "may be embedded within each other, thus allowing for a hierarchical structure of schematic information." Harris provides the following example: while we have a schema for face which includes two eyes, nose, two ears, and mouth, we also have a subschema for the eyes which includes information concerning the pupil, retina, iris, and eyelid. Other subschemata present are those for the nose, the ears, etc. All these subschemata are subsumed under the most comprehensive schema "face". (Harris Chapter 9: 23).

The third characteristic of schemas is that they vary in their level of abstractness. Harris (Chapter 9:23-24) explains that we have very specific schemas, such as the appearance of a capital A; but we also have general schemas such as the different literary genres, e.g., what to expect from a mystery story, western, or television soap opera.

Anderson (1980:150) points out that Schemas are important knowledge structures that enable us to deal effectively with the information processing demands of a large and complex world. They serve to extract and categorize clusters of experiences in that world.

Cognitive Psychology has emphasized the powerful role the reader's knowledge of the world or his background knowledge—as represented in schema—plays in the processing of written materials. This means that when reading for comprehension, the reader interacts with the information conveyed by the text by making use of his knowledge of the world to properly construct an interpretation of what he

is reading. What the reader brings to the text is generally as important as what he finds in it—it is this previous knowledge that enables him to make sense of what the text is about. Harris (Chapter 9:22) remarks that a "fundamental assumption of [schema theory] is that a written text does not in itself carry meaning but rather provides directions for listeners or readers on how to use their own stored knowledge to construct the meaning."

This means that when reading for comprehension, the reader goes beyond the information available in the text and fills in the missing information by inference basing on his knowledge of the world.

This way reading can be considered as a constant process of guessing, predicting, evaluating, and asking oneself questions that might be answered by the text. (Grellet 1982:4) The role of the reader is thus an active one—he has to construct the meaning of the text by himself. Smith (1981:105) calls attention to the fact that "reading is asking questions of printed text. And reading with comprehension becomes a matter of getting these questions answered."

It may be worth noting that we can only make sense of what a reading stimulus is in terms of what we already know, that is, in terms of the knowledge of the world we have acquired throughout the succeeding years of our existence. This personal knowledge is in fact the fundamental basis for our perception and understanding of the world around us—it is also the basis for all our learning. Thus, we make sense of the world by referring to this knowledge and we learn more by modifying and elaborating this preexisting knowledge. (Smith 1981:81).

Furthermore, one cannot understand what is not meaningful to him. It is a common situation to refer to a piece of written material as difficult or badly written if one fails to properly understand it. This lack of comprehension might be due to the fact that the reader does not have the necessary background information to interact with the new information provided by the text in question. In this case, the problem is not with the text itself, but with the gap between the amount of information in the text and what the reader already knows.

Moreover, it is very difficult for a reader to understand a piece of discourse which apparently has no theme—as the reader feels incapable of forming the overall gist of the written passage, he cannot construct an interpretation based on what he already knows. For example, suppose the following passage is given to our class of students:

With hocked gems financing him, our hero bravely defied all scornful laughter that tried to prevent his scheme. "Your eyes deceive," he had said, "an egg not a table correctly typifies this unexplored planet." Now three sturdy sisters sought proof, forging along sometimes through calm vastness, yet more often over turbulent peaks and valleys. Days became weeks as many doubters spread fearful rumors about the edge. At last from nowhere welcome winged creatures appeared signifying momentous success.*

The predictable outcome is probably total lack of comprehension. What happens is that the

students do not have at their disposal a title, a word or situation that could inform them which previous knowledge should be used to accept the new incoming information and, consequently, construct an interpretation of what they read. The information conveyed by the passage is not consistent enough in guiding the students in their task of forming predictions about the real content of the passage. As a result, they cannot use their previous knowledge to properly understand its meaning.

On the other hand, if this passage is re-read having in mind the title "Christopher Columbus Discovering America", the students can probably make sense of the information presented and construct a correct interpretation. They are capable of assigning meanings and interpreting what they have re-read because they supplement a great deal of information that is not provided by the passage based on their previous knowledge about Columbus and what he did. In other words, by having in mind an appropriate schema with slots for ocean travel, how the voyage was financed, the types of ships used in the voyage, the kind of people that welcomed Columbus, the students can then easily interpret what they have just read. (Moates and Schumacher 1980:196). What happens is that the schema which was retrieved accounts for the various words and sentences that could not be interpretable at the time of the first reading.

A point to be re-emphasized is that new incoming information is accurately comprehended only if it can be associated with the reader's existing knowledge stored in his long-term memory. This is true in all the stages of information processing, that is, from the moment

new information comes into our brains to its encoding in long-term memory.

4. FINAL REMARKS

This paper has considered some theoretical issues in cognitive psychology and has related them to the reading process. These issues, in turn, have brought about some changes of perspective in the current teaching of FL reading.

First, as it was pointed out, the flow of new incoming information progresses from environmental stimuli to encoding in long-term memory. This means that when constructing the meaning of a written text, we progress from its overall meaning towards a deeper and more detailed understanding. Therefore, the current reading lesson ranges from prediction as a lead-in to the topic of the text towards intensive comprehension involving, of course, the reader's knowledge of the world in all the stages of information processing, which may foster a better retention.

Secondly, the view of comprehension as an interactive process is another change in perspective. Since text comprehension involves both text information and the reader's knowledge of the world, reading is no longer considered as a passive activity, it is rather an active interaction which involves the reader in "a negotiation of meanings." (Widdowson 1984: 64). The reader is thus expected to make use of what he already knows to form hypotheses, check them, make inferences, go outside the text to understand the context of situation, and so forth. Therefore, the teaching of reading usually

makes use of reading material which is meaningful to the students, that is to say, within the students' spectrum of previous knowledge. There must be always a shared area between what the students know and what the text presents, otherwise no comprehension can take place.

Thirdly, another point in the change of perspective is that the reading material is graded according to the students' background knowledge and not lexical and grammatical difficulties. The greater the shared knowledge between what the students know and what the text presents, the easier is the processing of new information towards comprehension and retention. In other words, the more links the students can establish between the new information being processed and information in their long-term memories, the easier comprehension becomes.

A point that seems paradoxical should be made concerning the reading material. As just mentioned, the reading material must be meaningful to the students, that is, the students must possess some previous knowledge to interact with the new information provided. On the other hand, this reading material must also be challenging to the students in the sense that it must present some further information that the students do not have yet. The students can then use this new information either to alter or simply to incorporate it into their preexisting knowledge.

A further point to mention in relation to the reading material is that authentic texts are used in the reading classes to the detriment of constructed or simplified versions. This means that the text iconography, accompanying illustrations, grammatical and lexical items are

totally retained. In order to bypass or lower the linguistic difficulties of authentic texts, two criteria of grading must be taken into consideration: first, as just pointed out, grading of reading material according to the students' preexisting knowledge; secondly, grading of the reading comprehension activities required of the students, that is, from reading for gist in the first lessons towards intensive comprehension.

In closing, it may be relevant to reiterate that text comprehension ties together linguistic competence, knowledge of the world, the use the reader makes of context and the interpretation of the accompanying nonverbal features of a piece of written discourse. The point to bear in mind is that when actively involved in his task of constructing meaning, the reader deals with all these elements as a whole — one element supplements the understanding of the other, all elements are used for an accurate comprehension of the whole. Everything is in fact simultaneously processed in the reader's active interrogation of the meaning of a text.

NOTAS

* This paper is a version of Chapter II of my dissertation "The Semiotics of Written Discourse and the Dual Representation of Information in Memory: an Application of Nonverbal Elements to FL Reading Methodology", presented in October 1984 to the Graduate School of FaLe-UFMG in fulfillment of the requirements for the degree of Mestre em Inglês.

* The discussion of comprehension and the information-processing system is mostly based on

lectures, handouts, and classroom discussions during the courses given at UFMG by the visiting Professor Dr. Richard J. Harris from Kansas University, during the second term in 1982. The specific discussion of comprehension is mostly based on Chapter 9 of the book Human Learning (forthcoming).

* This discussion of the information-processing system is mostly based on Harris, Chapter 7 of the book Human Learning (forthcoming). Harris, in turn, acknowledges his debt to the model of R. C. Atkinson and R. M. Shiffrin.

* D.J. Dooling and R. Lachman, as quoted in Moates and Schumacher, 1980, p. 187.

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