Assessing comprehension of medical texts: a new approach to recall analysis

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ABSTRACT

Background *The comprehension processes are often inferred or explored indirectly through the assessment of the performance of the students on certain tasks. Comprehension is typically measured by the techniques in which the test-taker reads a short text and then selects the correct answers in multiple choice questions, true/false and yes/no tasks or matching activities.*

Purpose *A new approach to the analysis of recall protocols, written by medical students, is devised which is mainly based on the performance analysis.*

Methods *Three texts have been selected out of the pool of 20 texts based on the medical students' level of familiarity content. Care was taken to select texts of the same level of readability. The language proficiency of the students was measured by English Language Battery Test (ELBA test). The students read the texts and wrote recall in their mother tongue. Half the students did the ELBA test before reading the texts and writing the recalls and the other half did the task in reverse sequence. The recall analysis, so that the emphasis is on students' performance at two levels: identification and interpretation processes.*

Results *Identification processes and interpretation processes are interacting efficiently when a content familiar text is used. The unfamiliar text, when read by a student with prior language proficiency, is not efficiently comprehended. However, when familiar text is read by the same student, he can compensate his poor language proficiency by resorting to his prior knowledge.*

Conclusion *Interaction between different knowledge sources are better demonstrated when recall is used as the technique for measuring reading comprehension.*

Keywords *RECALL, LANGUAGE PROFICIENCY, MEDICAL LANGUAGE, READING*

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Introduction

The assessment of reading comprehension is rarely a straightforward task since reading comprehension itself is a complex cognitive process which is not easily observable and therefore is not open to direct assessment. The comprehension processes are often inferred or explored indirectly through the assessment of the performance of the students on certain tasks. The extent to which the researcher's judgments about these processes are valid and correct is closely related to the strengths and limitations of the method.

The methods of assessment are different in many respects including the type (orientation) of the method, and the type of the response (Bachman 1990). Some methods are product-oriented (off-line), that is the task is performed after the reading process is over as in the case of close, recall, standardized comprehension tests and retrospection, and some are process-oriented where the test-taker's performance is observed while reading, such as eye-movement studies and miscue analysis or self report data and introspection.

Comprehension is typically measured by the techniques in which the test-taker reads a short text and then selects the correct answers in multiple choice questions, true/false and yes/no tasks or matching activities. The purpose of these tasks is to provide insights into how much the reader has comprehended and/or from which part of the reading text the reader has collected information. One major advantage of these techniques is that they are very easy to administer and code. In particular when a large group is being tested, multiple choice answers provide the potential to be corrected by computers. Another advantage is that the questions and answers themselves provide certain retrieval cues which can override memory retrieval constraints from which all product-oriented tasks suffer. However, the emphasis of the method sometimes is so

much on the detail and unimportant information that it may encourage readers to resort to bottom-up processing rather thatn to interactive processing (Swaffar 1991).

The theoretical validity of the traditional comprehension tests for measuring comprehension has been widely criticized by many scholars and researchers (Davis 1995,). Some of the reported limitations are related to the questions themselves such as being passage independent, so that they may be answered without reading the passage by utilizing prior knowledge (Wolf 1993,). Meyer (1975) argues that the questions fail to make a distinction between important and unimportant information in the text. The questions themselves may not be well understood by the reader since they are in the target language (Wolf 1993,), and even may provide additional information to the text that may be used to answer the other questions (Gordon). The reader also may become expert in answering these questions and using some strategies which are not related to those of reading comprehension, this is normally referred to as "test-wiseness" (Bachman).

In the present study it is argued that reading comprehension is the result of the interaction between different knowledge sources (Romelhaurt) and the assessment technique should reflect the nature of this interaction. The method of the analysis of recall protocols, in this study, provides evidence of interaction between different knowledge resources.

Analysis of recall protocols

The notion of qualitative anlysis of recall follows that of Bernhardt (1983), Bernhardt and Berkemeyer (1989) and Allen et al. (1988), but there are some significant differences which affect the conception of the framework for the analysis developed for the present stdy. Bernhart's analysis is mainly based on error analysis and emphasizes on the reasons for comrehension breakdown. Bernhardt argues tht the analysis of the errors indicates the literacy development amon the subjects. However, in the present study, the focus of the analysis is based on the students' performance which inevitably covers the error analysis as well. The performance analysis reveals how a subject has constructed a mental understanding of the incoming information in which both the correct and incorrect recognitions and interpretations of the incoming information play significant roles. Thus the performance shows what has been recognized or misinterpreted. In fact the word performance analysis has been adopted from Faerch and Kaspar (1987).

Material and Method

The study was conducted in Shaheed Beheshti University of Medical Sciences and Health Services (Shaheed Beheshti UMSH) in 1999. Two texts, out of the pool of 20, were selected based on certain second-year students' rating and also the University lectures' rating of students' familiarity with the content of the texts. After the selection of the texts, 63 students in their second year of study were randomly selected (of course not of those who had previously participated in the selection of the texts). They sat for English Language Battery Test (Elba test) and read the texts and wrote recall. When reading the texts, the students were asked to answer a multiple choice question regarding their level of content familiarity. Half the students did the ELBA test before reading the texts and writing recall and the other half did the tasks in reverse order. Half the subjects read one text before reading the other one and the other half read the text in reverse order. Thus each student read two texts and wrote two recall protocols.

Qualitative analysis of recall protocols (The analysis of performance)

To analyze the reader's performance in a recall task, reading processes are classified into two broad categories: identification and interpretation processes which are of conceptual nature and hence are reader's characteristics.

Identification processes have text-based representations and are driven by text; interpretation processes do not have any text-based representations. Identification processes are the application of reader's knowledge sources in identifying the clues of features in the text. In this perspective, the terms "knowledge" and "skill" are used interchangeably since when it is demonstrated that a reader is in the "possession" of a knowledge it means that the reader has demonstrated skill in applying that knowledge in interacting with the text. In other words, identification processes are the skills of applying the language knowledge sources in recognizing the clues in the text and interpretation processes concern skills of applying the conceptual and extratextual knowledge sources in interpreting what has been or is being identified by identification processes. Identification processes fall into three categories:

1. The Automatic word perceptual/identification skills the analysis of the subjects' performance in automatic word and subword recognition is based on four criteria. The first is *recognition* which refers to the exact recall of a word from the source text. The second criterion is *phonemic/graphemic feature misrecognition* which means misrecognising a word from the source text with another work based on the phonemic/graphemic similarities such as misrecognition of the word *organisation* as *organism*. The third is *whole word misrecognition* which refers to the recall of a word which is not in the source text and is misrecognised with a word from the source text, for instance recalling the word *morbidity* instead of the word *product*, where the subject has read the word *product* and thinks that it means *morbidity*. The fourth criterion is ***non-recognition*** which refers to the words from the source text which are not present in the recall protocol. Since the analysis was based on performance, it was necessary to include the words which are recognized as well, but

the number of words which were recognized in some cases was so high that it was impossible to mention all of them. In order to solve this problem, at first the key vocabulary items which signal the main information were selected and then in an analysis of the selected recall protocols, the vocabulary items which were not key words but caused comprehension problems were identified and were added to the key words, then the performance of the subjects on these words were reported. One of these words which was not a key word and was important in the analysis and caused comprehension problem was the word *organisation* in the Panels text.

2. Syntactic feature identification skills these involve the identification of the relations between words and their syntactic categories. Syntactic recognition is divided into ***syntactic category recognition***, which refers to the correct identification of the ***syntactic category misrecognition***, which refers to the misidentification of the syntactic categories of the identified words such as recalling an adjective as a noun, singular as plural, ***syntactic structure recognition***, which refers to the correct identification of the syntactic structures, ***syntactic structure misrecognition*** which refers to the misidentification of a passive as active, subject as object. The last criterion is ***syntactic structure non-recognition*** which refers to those structures which are present in the source text but not in the recall protocol.

   Failure at identification of the relations between words can be seen when the reader recalls the SVO structure as SOV or a passive sentence construction as an active one. An example of that would be recalling *groups of people survey* instead of *surveying groups of people*. Failure at identification of the syntactic categories of the words can be found when the reader recalls an adjective as a noun, or passive as active. However, if the subject changes the syntactic structure or the syntactic category of the word in a way that it does not change the meaning of the text, then it is not considered as a misrecognition or failure (while in Bernhardt's method it was considered as failure). Two examples of that would be when the subject reads *do not give a detectable reaction* and recalls it as *do not react detectably* or when the subject reads *when the animal serum is injected* and recalls it in an active form without much change in the meaning as *when we inject the animal serum*. Thus correct paraphrasing or approximating information by simplifying them are considered as steps toward construction rather than errors and are not neglected in the analysis either.

3. Macro-structure identification skills these refer to the identification of those features or clues in the text that connect sentences, paragraphs or chunks of the text together. These clues or features are for the main part rhetorical structures (as suggested by the superordinate structure of Meyer's analysis) or any structure with text-based representation that operates above the level of syntactic structure such as cohesive links. Ability in macro-structure recognition in recall is demonstrated when the subject can recognize the following features:
   a. The top-level rhetorical structure recognition/misrecognition.
   b. The lower level rhetorical structure recognition/misrecognition
   c. The explication of cohesive links
   d. Sequence and arrangement of information in the text (structure strategy).

   Recognition or misrecognition of any of these features is recorded in the analysis. For example, the top-level structure of the Coombs' test text is a problem solution structure, where the subject either recognizes it correctly, misrecognises it with another rhetorical structure or does not recognize it at all are given attention to in the anlaysis.

Interpretation processes demonstrate the ability in comorehending the information in terms of reasoning and conceptual understanding (Grabe). Interpretation processes also fall into three categories:

1. Synthesis and evaluation skills synthesis and evaluation skills refer to the ability to synthesise the missing information from the context and to predict the flow of information in the text (Grabe) synthesis is similar to macro-structure recognition; the difference is that synthesis is the ability to integrate information from various parts together when there are no text-based clues. The ability to paraphrase the information, to explicate the hidden information, recombine the information and to reason based on the context fall into this category. Poor performance in synthesis is manifested in recall when the subject approximates the information by missing some important points and simplifying the information or when what has been recalled is not well contextualised, that is, the bits of information which are recalled do not fit with each other. In all these cases the subject's performance is analysed as good or poor. Evaluation of information is the ability to compare the incoming information either within the text (context) or outside the text (world knowledge). In evaluating the incoming information with other sources of information the reader may take a position with respect to the information being processed, such as finding it useful, boring, persuasive, interesting (Grabe).
2. Metacognitive knowledge Metacognition interpretative ability refers to the cognition about cognition. It refers to awareness of the process of comprehension. Conscious use of this ability is seen when there are lacunae in comprehension and the subject is aware of that and leaves some parts blank or puts question marks. Uncertainty of comprehension is reflected in recall when the subject writes parenthetical comments or provides

two different perspectives about one information by using *or*. Unconscious automatic use of this ability is seen in recall when the subject writes a coherent recall. It goes without saying that incoherent recall reflects weakness in using metacognitive knowledge. Paraphrasing or approximating the message by simplifying the text is considered conscious compensatory strategies in comprehending the incoming information.

3. Content/word knowledge Prior knowledge interpretative processing is the process in which the reader uses one or a combination of the following knowledge sources to interpret the incoming information:
   - Prior knowledge of the word
   - Prior expectations of the content of the reading text
   - Prior knowledge of the content of the reading text
   - Personal experiences
   - Knowledge acquired through reading the text (context).

An example of the trace of prior knowledge in recall is when the reader recalls "monkey" instead of "goat" after reading the sentence It is produced by injecting human gamma globulin into goats or rabbits in Coombs' test text. The word monkey comes from reader's prior knowledge of testing on monkeys rather than goats. An example of the influence of prior knowledge on identification of the word organizations as organs because of the prior expectation of reading a text in medicine rather than in psychology.

Results and discussion

The results of the analysis of two students at two levels of language ability low and high are presented here to demonstrate how different knowledge sources interact and how a mental representation of a reading text forms among medical students.

Student No.20 with language proficiency 14/100

Student no 20 reported that the Panels text was unfamiliar and the Coombs' Test text semi-familiar. His/her ELBA test score was 14 out of 100 which is considered low in language proficiency. The complete backtranslation of her/his recall of the Panels text is as follows:

The recall of the Panels text by student No. 20

Most of the organisms are interesting for a continuous study or their morbidity. For this very reason, a group was sent to study them specially among housewives and that to study the products ...

From the above it appears that the student, being a medical student, expected to read a medical text, rather than a text in psychology. Several terms are interpreted in the context of medical discourse (Table 1) and are connected together in an attempt to construct a coherent model of the text meaning. However, it seems that the initial expectation by the student was that the text would be in medical discourse. The misrecognition of the word *organizations* as *organism* has resulted in the predominance of the initial expectation on the comprehension. The student has both misrecognised a word at identification level and has used her/his prior expectation of the reading text in understanding the text (Table 1).

Except for a few traces of the information conveyed by the first few sentences of the source text, the main text information ahs not been identified. Although the rhetorical structure of the text has been correctly identified, it has not helped the student understand the message. The correctly identified words are few in number, indicating inadequate bottom-up processing. Thus the identification processes have provided poor quality information for higher interpretative processes and this has resulted in the dominance of the initial expectations of the text (prior knowledge) in constructing a mental representation of the text meaning. The initial expectations of the reading text and the activation of schemata not related to the reading text have infiltrated the recall protocol and led to a unique and inaccurate interpretation of the text meaning (Table 2).

The analysis indicates that the student has attempted to use certain strategies such as inferencing, synthesizing the information and using the context to understand the text information in constructing the mental map of the text. However, these strategies have not resulted in a successful interpretation of the text information since the inferences which were made were inappropriate, the information provided for synthesis was poor and inadequate, and the context was not sufficiently well established to be of any help in comprehension. Apparently, the misrecognition at the level of identification processes has influenced the interpretation processes.

It seems that since the student is low in language proficiency and unfamiliar with the content of the reading text, she/he has used certain strategies which are of compensatory nature such as using circumlocution, approximating the message, and using context to infer the unknown vocabulary items. However, these compensatory strategies do not seem to have aided the successful comprehension of the reading text.

In order to see whether there are improvements in the reconstruction of information and strategy use with a text shoes ocntent is meant to be familiar, the recall protocol of the same student reading the Coombs' Test text is analysed. The student reported that the content of the text is semi-familiar. The complete backtranslation of her/his recall protocol is as follows:

The recall of the Coombs Test text by student No.20

Red blood cells have certain particles at antigen-binding sites and also they contain Zeta potential which prevents the cells from getting close to the particles and from producing hemagglutination. It was also about human antibodies and the way in which serum and antigen are

produced in the body in that the immunoglobulin bridge is an antibody against human immunoglobulin which can be produced by injecting antigen to animals and making the necessary antibodies for human body can not have sufficient defence against that antigen. When the animal serum is injected into human body, it causes the two immunoglobulins to join.

Most of the medical terms and the sentences are recognized correctly. However, the first sentence of the source text and the sentence related to the *principle of the Coombs' Test* which signal the problem-solution structure of the text have not been recognized. The protocol instead is based on a "collection" structure based around the two ideas: what red blood cells are and how a serum is made (Table 8.3).

The two chunks of descriptive information are synthesized almost correctly and have received adequate bottom-up support. However, the two descriptive ideas, of representing the two subschemata of Coombs' Test, could not lead to the activation of knowledge of the Coombs' Test itself. The student elaborates on the text information to guide the reader which not only indicates awareness of comprehension but also the ability to use prior knowledge to make appropriate inferences. Some additional understanding with no text-based support has also been recalled, such as for the time when human body cannot have sufficient defence against that antigen which indicates the influence of prior knowledge of the content of the text (Table 8.4). This interpretation does not relate to the Coombs' Test directly but to other information in the text.

In the familiar text, in contrast to the unfamiliar text the student did not misrecognise any words with phonemic/graphemic similarities and recognized nearly all the syntactic structures and lower level rhetorical structures. The errors in identification processes are dramatically higher in the unfamiliar text.

Understanding the top-level structure in the unfamiliar text has apparently not assisted the student in activating the relevant information in the unfamiliar text. Even without the recognition of the top-level structure, the student has written a meaningful and coherent recall.

The student has clearly applied her/his interpretative ability to the information provided by the identification processes and it seemsa that the limitation ad the accuracy of the interpretative processes have been defined by the quantity and quality of information derived from the identification processes. Not having the relevant prior knowledge, poor quality information provided by identification processes has led to the activation of irrelevant schemata and this irrelevant schemata, fuelled by the synthesis, evaluation and metacognition processes, has resulted in a model of text information which is completely different from that of the source text.

In the synthesis and evaluation category of the familiar text, the student paraphrased some information and written a meaningful recall. In the unfamiliar text, the student failed to synthesise the information in spite of her/his attempt to do so. The recall of the familiar text, as opposed to the unfamiliar text, is more coherent, and contains appropriate inferences, explications of information and circumlocution that are indications of awareness of comprehension and metarecognitive strategy use.

Prior expectations of what the text would be, have infiltrated the recall of unfamiliar text and since the student could not use her/his language skills properly in order to generate an effective bottom-up processing she/he could not reject the initial hypothesis.

Certain strategies such as using structure strategies, explications of cohesive links circumlocution and explication of information are utilized in the content familiar text (which the student has reported as being semi-familiar) (Table 8.4). Strategies such as making inferences, using prior knowledge in comprehending the information, attempting to make a coherent construct are utilized in both recall protocols, but they are more effective and constructive in the content familiar text (Tables 8.2, 8.4). In both protocols, the student is aware of what she/he could not comprehend.

Discussion

The interaction between different knowledge sources is very well presented when recall protocols are analysed based on the method presented in the present study. Familiar text results in better interaction between knowledge sources suggesting of using texts which are familiar and related to the discipline they are studying in this case medical texts. It is recommended that recall be used as the method of choice for measuring reading comprehension.

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IDENTIFICATION PROCESSES (TEXT-DRIVEN PROCESSES)			INTERPRETATION PROCESSES (KNOWLEDGE-DRIVEN PROCESSES)		
Word/Subword Recognition	Synthesis and Evaluation	Metacognition	Prior knowledge	Syntactic Feature Recognition	Macro-Structure Recognition
• Word recognition: the words *continuous, group, housewife* are recognized correctly. • Whole word misrecognition: *measurement* is misrecognised as *study, product* is misrecognised as *morbity* • Phonemic/graphemic feature misrecognition: *Organisation* is recognized as *organism*. Non-recognised words: more than 90% of the words were not recognized.	• The students has attempted to approximate the message by synthesizing a model of text meaning based on what has been recognized and misrecognised • The words: *organisms, morbidity, interesting, group, housewives* have been integrated with one another and contextualised in a problem/solution format in a medical discourse which is different from the original text.	• The recall is incoherent. The student has written a *group was sent to study them specially among housewives* in this sentence them refers to *organisms* which does not make sense because there is no relation between *organism* and *housewifeves*. • Inferences are inappropriate such as a *group was sent* and *morbidity*. • The student is uncertain of comprehension and has not ended the recall • The main information such as what panels are, as well as lower level information has been omitted.	• The student's initial expectation of the reading text that it is probably related to a medical genre has dominated her/his construction of text meaning. • The initial hypothesis has been dominant in recall and has provided a prior context for interpretation of the rest of the text. Thus misrecognising *organizations* as *organism* has been used as prior context to interpret *product* as *morbidity*.	1. Syntactic category recognition:*organisms*,*continuous* were recognized correctly. 2. Syntactic category misrecognition: *interested* is misrecognised as *interesting*. • Syntactic structure recognition: In the first sentence, the student and object relationship has been correctly identified, but the meaning of the sentence is different from the original sentence. Syntactic structure misrecognition: none.	• Top-level structure of recall protocol: the rhetorical structure of the text has been signaled correctly. The student has written the recall with a problem/solution format. • Lower level rhetorical structure of protocol the rhetorical skeleton of the text is not recognized. • Selection of cohesive signals. • Recognition of topic/gente. The topic of the text which is psychology is misrecognised as a medical topic. • Understanding the sequence of information: The ideas are not arranged following the same sequence as if the source text.