Reading Process: Evidence from Think Aloud Procedure

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ملخص

شارك في هذه الدراسة عشرة طلاب، تخصص علم الأحياء الدقيقة. وتهدف الدراسة إلى تحديد كيفية معالجة الطلاب للمعلومات وأنواع الاستراتيجيات التي توظف في فهم المعلومات. قمنا بتحليل إستراتيجيات القراءة للطلاب أثناء قراءة نص تفسيري باللغة الانجليزية باستخدام التفكير بصوت عال. كشف تحليل البروتوكولات منظورين لعملية القراءة: منظور القارئ ومنظور النص. كما كشف الإجراء الذي يستخدمه الطلاب : بناء المعنى، التحقق من الفهم، و تفعيل استراتيجيات الوصول إلى الفهم.

Abstract

Ten subjects, majoring in microbiology participated in this experiment. The study aims at identifying how the students process new information and what strategies they employ in order to retrieve information as well as to understand it. We examined the reading strategies of the students while reading an English expository text using a think aloud procedure. The analysis of the protocols captured two perspectives of the reading process: the reader perspective and the text perspective. The results revealed that the subjects engaged in three main categories of reading strategies: constructing meaning, monitoring comprehension, and activating strategies to reach comprehension.

Keywords: Reading process; think aloud procedure ; ESP

Introduction

Reading is a dynamic, interactive process in which meaning is created. It involves complex negotiations between text and reader and is shaped by reader's knowledge of topic, language proficiency, purpose for reading, attitude, and motivation. The act of reading consists of the deployment of a range of different skills and sub-skills which underlie the reading process. Because of the silent and hidden nature of reading, the think-aloud procedure –adopted in this study- aims at developing knowledge of the learners' actual strategy use in a specific reading situation and of the actual execution of online strategies while reading. It has the advantage of providing access to reasoning processes that underlie reading.

1. Reading Process

Definition

Definitions of reading can generally be placed across a continuum of two opposing views, one focusing on the process of reading and the other focusing on the result of that process, the product. According to the first view, reading is primarily a decoding process involving, to cite Taylor and Taylor (1983), four signposts of letter and word recognition, sentence reading, story reading and reading for its own sake. On the other hand, according to Spink (1989), the reading process involves the perception of words, the comprehension of text, a reaction to what is read and a fusion of old and new ideas. From the 'product' point of view, reading is the process of constructing meaning from written texts, that is comprehending which requires the coordination of a number of interrelated sources of information and the dynamic interaction between the reader's existing knowledge; the information suggested by the text being read; and the context of the reading situation (Anderson et al., 1985; Wixson, Peters, Weber, & Roeber, 1987). Comprehension, then, is an active mental process. It is not something that a reader has; rather, it is something that a reader does. This process involves the author's ideas being seeded in the reader's background and the latter attempting to explore his or her own ideas, to modify them, to fit new ideas into the organization of his or her thinking, and to construct still new ideas, the reader is involved in a constant process of concept development (Farr and Roser, 1977).

We can notice that there is a big overlap between the above definitions, the reason being the difficulty to dissociate process and product even theoretically. Henceforth, and restricting ourselves to the two above views, and for the purpose of the study, we can conclude with a working definition of reading as follows: Reading is an interactive process between a reader and a text leading to the creation of meaning.

2. Think-aloud Procedure

2. 1. Definition

Think-aloud procedure (TAP) asks subjects to tell the researcher what they are thinking and doing i.e., everything that comes to mind while performing a task. While reading, the informants are instructed to keep thinking aloud, acting as if they are alone in a room speaking to themselves; they are prompted to talk when a long period of silence occurs, and asked to try not to plan out what they say or try to explain what they are saying. In other words, think-aloud refers to "stream of consciousness disclosure of thought process while information is being attended to" (Cohen, 1983:). Think-aloud verbalizations are tape and/or video recorded and then transcribed. Then they are content-analyzed and in many cases coded for specific categories which have previously been developed by the researcher.

2. 2. Objectives

Think-aloud protocols have been widely used in both L1 and L2 reading research both as an exploratory methodology with the aim of obtaining the mental processes of readers in different situations and as a means to test hypotheses about reading. According to Pressley and Afflerbach (1995), the suitability of the method to the different areas of investigation within the wide discipline of reading has provided rich description and understanding of reading. Due to the complex nature of the readers' thoughts and actions, many studies focused on single aspects of reading and on particular reader, process and strategy. Examples of such studies include determining main ideas (Afflerbach, 1990), summarizing texts (Brown and Day, 1983), demonstrating awareness of text cohesion (Bridge and Winograd, 1982) and

the monitoring of cognition (Garner and Reis, 1981). Other studies involved such independent variables as readers' prior knowledge or text genre.

2.3. Methodological Issues in Using Think-alouds

This section provides a methodological review about the think-aloud method and involves such components as informant training, characteristics of informants, the selection of the reading text, and language of verbalization. Because think aloud procedure is usually unfamiliar to most subjects, it can prove advantageous if not necessary to introduce the informants to the thinking-aloud task before they can be expected to perform it. This involves familiarisation with the method itself and the reason for conducting the study. Training is useful for subjects in that it provides them with feedback from the researcher before they start and helps ensure consistency of the thought reports across subjects.

As for subject characteristics i.e., how many and what kind of informants serve as verbal reporters, Rankin (1988) suggests that subjects should be chosen according to criteria set by the purpose of the study. If a study aims at examining the strategies used by readers of different levels of proficiency, it is not uncommon to have different levels of subjects in think aloud research. On the other hand, the number of subjects may be limited because of the practical constraints of transcribing and analysing the protocols. Nevertheless, the selected subjects should not only be representative of the research population, but they should also exhibit the characteristics under investigation such as age, level of proficiency, native language and learning background (Rankin, 1988). The informants may differ in their age, level of proficiency, native language and learning background. They may also be different in their ability to verbalize their thoughts.

Like subject selection, the selection of reading passages should also reflect the aim of the study. Criteria for text selection involve text length, difficulty and content. Passage length should be considered in the selection. Passages should be long enough to allow for subjects to get involved in reading, but it should not be so long that the subjects get tired by the

demands of thinking aloud for a long period of time. Generally, the characteristics of the research population are the deciding factors concerning the length of the passage (Rankin, 1988). The second criterion to consider in text selection concerns the level of difficulty. In this respect, when the cognitive load of the passage is too high it would make it difficult for subjects to think aloud. On the other hand, a passage that is below the subjects' ability will be dealt with only superficially, thus requiring little strategy use. Pressley and Afflerbach (1995: 14); however, state that "active and strategic efforts at meaning construction only occur in reaction to more challenging texts", and that when texts are difficult, reading is slower and consciously controlled, resulting in "substantial verbalization of information not explicitly given in the text" (Ericsson and Simon, 1988: xxxvi, cited in Pressley and Afflerbach 1995). Finally, the subjects' familiarity with the topic of the passage is an important factor to take into account. The subjects' responses to the passage may be biased if its subject matter requires prior cultural knowledge. Furthermore, if the researcher uses excerpts from larger works, s/he should take care that the understanding of the excerpt would not necessitate knowledge of the previous and/or subsequent parts of the larger work.

Another problem that may face the researcher using think-aloud procedure is the language of verbalization of think-alouds. Should it be in L1 or in L2? Advocates of the use of L2 give the argument that when L2 readers use their L1 to think aloud, it "may interfere with the way in which they perform the learning task" (Ellis (1994: 55). To minimize unwanted L1 interference, he suggests that participants use L2 as the sole means for verbalizing their abstract thoughts as reading the passage. On the other hand, a second group in favour of L1 use, suggests that in cases where all subjects share the same native language, it is more practical to give them a choice of language to verbalize since it would be difficult for less proficient subjects to do the task in the target language and verbalize in that language at the same time. This difficulty might distort the reading process and make the report counterproductive (Green, 1998). In Rankin's (1988) studies, the

subjects were also allowed to verbalize in whatever language they felt most comfortable using.

2.4. Analysis and Interpretation of Think-aloud Data

The data is analyzed in forms of protocols using a coding system and assigning each case of strategy use to a category. Here, the researcher may design his/her own categories. Olshavsky (1976-7), for example, identified and classified from her subjects' protocols three categories of strategies: word-related, clause-related, and story-related strategies. S/he may also borrow and/or adapt strategies found in research on learning strategies, systems developed out of particular theories of reading, or from other disciplines as cognitive psychology. Protocol coding is, thus, an interpretive act in the sense that the same data could be subjected to quite different coding systems, hence yielding quite different results according to different researchers with different assumptions (Smagorinsky, 1994). An important task for the researcher is then to thoroughly understand the theory underlying the study, delineate his/her own approach to the data and devise a coding system that corresponds to the investigation and describes the processes his/her theory anticipates. Criteria for protocol coding, thus, vary tremendously from study to study and a clear description of categorization in the coding system is vital (Rankin, 1988).

As far as the interpretation of think-aloud data, there are no clearly established means of reporting protocol data. In most protocol studies, researchers rely on few participants from whom to draw their results. Consequently, verbal report protocols are analyzed qualitatively, i.e. interpretatively without data quantification. In exceptional cases; however, when the size of the sample is large enough, the data will be quantified and subjected to statistical analysis in the same way as in any other normal experimental studies.

In sum, aspects of the verbal report methodology requiring special attention in the design and implementation of research based on protocol analysis involve the characteristics of

subjects, texts, choice of protocol excerpts, the categories to score think-alouds, and the reliability of coding of protocol contents.

2.5. Limitations of Think-aloud Protocols

Although verbal report data may emerge as useful research tools, their application has raised concerns related mainly to two aspects: the subjects' ability to reflect on their cognitive behaviour, i.e. the subjects may use strategies they fail to report (Cavanaugh and Perlmutter, 1982), and the truth value of the reports, i.e. subjects may report using strategies they did not really employ (Nisbett and Wilson, 1977). Baker and Brown (1984) question the accuracy of subject's reports on their own reading processes. In other words, the issue that remains problematic is whether verbal reports are genuine description of the actual processes the learners are involved in, or whether they are intelligent guesses based on the product.

The above review of the methodological issues of the think-aloud research reveals the fact that the latter is a promising means of investigating reading strategies. In addition to its flexibility, this technique can be adjusted to suit the aims of different research studies; "it is especially well-suited to the task of providing perhaps the most direct access we have to the mental processes involved in reading while it is going on" (Rankin, 1988:122). However, because of the above limitations of the method, some researchers call for more studies on the use of think-aloud as a method of capturing the learners' mental processes (Alderson, 1984; Cohen, 1987); whereas, some others strongly recommend data triangulation i.e., the use of multiple research methods for identifying and validating language learning strategies (Oxford and Crookall, 1989).

3. Method

3.1. Subjects

Ten subjects participated in this experiment; they are all fourth year Micro-biology students. The subjects are all in their final year of study and they have to prepare a dissertation on their speciality; much of the

documentation is written in English; thus, they need to read extensively in English.

3.2. Reading Materials

The study is based on an authentic text, i.e. one whose original form has been kept intact, the reason being that it is the sort of texts the subjects would read in their speciality and eventually for their dissertations. Furthermore, the topic of the text was not random. In fact, a list of topics was proposed to the subjects including: environmental microbiology, clinical microbiology and food microbiology. All the students chose a text from the second topic. It is entitled: "*Therapeutic Uses of toxins*". The topic, being chosen by the subjects, would motivate them and generate more interest in the information contained in the text. Hence, we believe that the more motivated and interested they are, the more they will verbalize their thinking processes. The length of the text -680 words- was motivated by the fact that it should be long enough for subjects to get involved in reading and make substantial verbalization.

3.3. Training

Before the actual experiment, a number of exercises were prepared to familiarize subjects with the think-aloud task; all the exercises involved thinking aloud while doing the activity. In the first exercise, the subjects were asked to solve anagrams. The second type of exercises gets the students to mentally multiply numbers. The third exercise was a dictionary search of unknown words. After the completion of the above activities, the subjects were given six examples of think-aloud responses taken from Olshavsky's (1976-77) study and translated into Arabic. Finally, the subjects practised the technique on two texts which they selected from the suggested list.

Three sessions were conducted before the real experiment. Each training sessions lasted between one to two hours, and all the sessions were practised on a daily basis. After one hour break and at the subjects' request, the recording of the actual experiment followed the third training session. In order not to disrupt the reading task and bias reports, the subjects were not

prompted by the researcher as they read. As for the language of verbalization, because the sample includes successful and less successful readers who may not be able to verbalize in English, choice was given to subjects to verbalize in whatever language they want Algerian Arabic, French, or English.

3.4. Identification and categorization of the strategies

After collection, the audio-recorded think-aloud protocols were transcribed in the original language which is a mixture of Algerian Arabic and French; then translated by the researcher. The next step consisted in matching the verbal protocols with the corresponding sentence. The following are examples from the protocols of one of the subjects

Text
A good example in this latter case is whooping cough; where the public acceptance of the whole cell inactivated vaccines has not always been high.

Protocol

I don't understand the sentence. I don't understand 'whooping cough'. I need a dictionary.
After I explain 'whooping cough' I'll carry on reading, maybe I'll reread the
sentence…mm I don't understand much. I will understand later

Text
Such a mutant protein is more likely for several reasons to be effective as a vaccine   than a toxin with gross alterations
Protocol
…I'll reread the sentence…I haven't understood 'alterations' …
It's 'altérations' in French, and so I've understood; I'll carry on.

Finally, each protocol was analyzed in order to identify strategies.

In preparing to identify and code the strategies uncovered during the analysis of the protocols, and based on related research, basically Olshavsky (1976-77), Anderson (1991), and Block (1986), a first list of strategies was tentatively identified. This initial list was then refined based on the collected

data. The process of refining the second list in order to acquire the list of strategies for the purpose of data analysis consisted in carefully reading through the transcripts and determining the parts of the protocol which contained the possible use of strategies. Seeking objective data analysis and following Newell and Simon's view (1972) (cited in Olshavsky (1976-77), categories and processes are determined from the data rather than imposed on it. At this stage, strategies which were identified in the data but were not found in the list of strategies were added to the list. As an example, 'adjusting reading rate' was found to be used by the students and hence was added to the list of strategies identified. On the other hand, strategies which were put in initially but were not identified in the data were omitted from the list. For instance, the strategy of 'summarizing' was omitted from the final list because it was not identified in the protocols of the actual study. In short, strategies were added to or deleted from the final list to reflect the strategies identified in the data of the actual study until a stabilised list of strategies was obtained.

To make sense of the text, readers construct meaning by interacting with the reading materials using strategies which refer to operations or actions that are deliberately employed by readers to accomplish the reading task and enhance learning. In the think-aloud data, the strategies have been categorized under these two broad categories: text-initiated (bottom-up) and reader-initiated (top-down) strategies.

Text-initiated strategies include problem-solving skills which rely mostly on the visual signs and focus more on the structural aspects of text. The strategies grouped under this category involve (i) focusing on vocabulary, (ii) relating sentence with what preceded or follows, (iii) using the title, and (iv) relating table to text. The grouping of text-initiated strategies applies at three levels: word level, sentence level and text level. *Word-level strategies* include:(i) analysing the grammatical form, (ii) relating word with a French word, (iii) relating word with an Arabic word, (iv) relating word with an English word, (v) using context, (vi) skipping, (vii) questioning (word-related) , (viii) stated failure to understand a word, and

(ix) expressing need for a dictionary. *Sentence-level strategies* involve: (i) rereading, (ii) relating sentence with what precedes, (iii) questioning (idea-related) , (iv) reading sentence word by word, and (v) reading aloud. Finally, *text-level strategies* involve: (i) expressing need to reread paragraph, and (ii) establishing link of the title with text.

Reader-initiated strategies, on the other hand, focus primarily on the readers' reactions to the text content including invoking prior knowledge, predicting, evaluating comprehension progress, inferencing. While doing this, readers utilize more information from within themselves rather than directly obtainable from the visual text. The established list of strategies involves the following: (i) guessing, (ii) rejecting of confirming guess, (iii) inferencing, (iv) invoking prior knowledge, (v) addition of information, (vi) reading on, (vii) evaluating comprehension progress, (viii) predicting, (ix) paraphrasing, (x) expressing feeling, and (xi) adjusting reading rate.

Our final list which consists of 27 strategies will be used as a template for analysing the reading behaviour of our subjects.

4. Results of the Think-aloud Procedure

After the collection of data, and the identification and categorization of the strategies, the verbal protocols reported by the subjects are analyzed quantitatively −subjected to statistical analysis including frequencies and percentages− then they will be analyzed qualitatively, i.e. interpretatively in terms of the categories of strategies used.

4.1. Quantitative Data Analysis

The frequencies for strategy use by the whole groups are given in the tables below.

Table 01: Frequency for Strategy Use by the whole Group

Students	LM	LN	TI	BS	KS	KF	DH	OL	DA	BM	
A/ Text-initiated Strategies											Sub-Total A
(i) word-related											
Analyzing the grammatical form	09	03	19	06	11	01	09	04	07	02	71

Relating word with a French word	30	26	40	22	20	04	06	05	09	05	167
Relating word with an Arabic word	00	02	01	01	09	01	09	10	13	05	51
Relating word with an English word	01	00	08	04	13	03	01	01	00	02	33
Using context	03	01	05	05	08	04	02	02	01	00	31
Skipping	00	03	11	01	01	00	00	00	00	00	16
Questioning (word-related)	02	05	14	00	07	02	04	29	03	08	74
Stated failure to understand a word	24	20	43	28	20	24	55	35	25	53	327
Expressing need for a dictionary	22	11	22	13	04	00	22	26	25	28	173
Sub-total(01)	91	71	163	80	93	39	108	112	83	103	943
Percentage	41.17	49.65	51.09	42.32	41.33	34.51	54.27	57.73	41.91	54.78	47.41
(ii) Sentence-related											
Rereading	19	19	40	31	41	14	30	10	33	20	257
Relating sentence with what precedes and follows	02	03	02	00	00	01	00	00	01	01	10
Questioning (idea-related)	02	01	09	00	06	00	00	03	01	08	30
Reading word by word	00	01	00	00	00	00	06	03	02	01	13
Reading aloud	00	01	00	00	00	01	00	08	01	11	22
Sub-total (02)	23	25	51	31	47	16	36	24	38	41	332
Percentage	10.40	17.48	15.98	16.40	20.88	14.15	18.09	12.37	19.19	21.80	16.69
(ii) Text-related											
Expressing need to reread paragraph	03	02	01	03	01	03	01	01	01	02	18
Establishing link of the title with text	01	00	01	00	00	00	00	00	00	00	02
Sub-total (03)	04	02	02	03	01	03	01	01	01	02	20
Percentage	01.80	01.39	00.62	01.58	00.44	02.65	00.50	00.51	00.50	01.06	01
B/ Reader-initiated Strategies											Sub-Total B
Guessing	16	02	03	07	10	00	07	00	01	05	51
Rejecting or Confirming guess	03	02	08	02	07	01	01	01	02	00	27
Inferencing	07	01	08	05	02	01	00	01	04	00	29
Invoking prior knowledge	27	01	20	23	19	04	05	11	06	05	121
Addition of information	06	03	07	03	04	00	01	06	02	03	35
Reading on	14	14	19	04	12	17	16	05	08	01	110
Evaluating comprehension Progress	30	21	33	25	28	29	24	26	43	20	279
Predicting	00	00	03	06	01	00	00	00	00	00	10
Paraphrasing	00	01	02	00	01	03	00	01	04	05	17
Adjusting the reading rate	00	00	00	00	00	00	00	04	03	01	08

Expressing feeling	00	00	00	00	00	00	00	02	03	02	07
Sub Total (04)	103	45	103	75	84	55	54	57	76	42	694
Percentage	46.60	31.46	32.28	39.68	37.33	48.67	27.13	29.38	38.38	22.34	34.89
Total	221	143	319	189	225	113	199	194	198	88	

The table above is divided into two sections: A, and B. Section A consists of the text-based strategies and is also divided into three sub-section: word-related, sentence-related, and text-related strategies. Section B consists of the reader-based strategies.

The table shows the number of strategies used by each student (sub-totals (01), (02), and (03) in Section A and sub-total (04) in Section B). In addition, the corresponding percentage for sub-sections is calculated by adding the figures in sub-total A and sub-total B, then dividing each sub-total by the global number of strategy of both sections. Thus, say for the student named LM (the initials of students' names are used for the sake of anonymity), the number of text-related strategies is 118 strategies distributed as follows: 91 (41.17%) for word-related strategies, 23 (10.40%) for sentence-related strategies, and 04 (01.80%) for text-related strategies as shown in sub-total A (01), (02), and (03). Additionally, sub-total B shows that the number of reader-based strategies (for LM) is 103 (46.60%). Adding these sub-totals from both Sections A and B will give a total of 221. This figure indicates the instances of strategy use attributed to LM. To obtain the percentage of word-related strategy use by the student LM we divide 91 by 221 and we get 41.17%.

There were 1989 instances of strategy use. The strategies were ranked based on the frequencies and percentages from the highest percentage to the lowest. The mean of each strategy was also calculated. Table 2 below displays the ranking of the top 10 strategies.

Table 02: Ranking of Strategies

Rank	Strategy	Total	%	Mean
1	Stated failure to understand a word	327	16.45	32.7
2	Evaluating comprehension progress	279	14.02	27.9
3	Rereading	257	12.92	25.7

4	Expressing need for a dictionary	173	08.69	17.3
5	Relating word with a French word	167	08.39	16.7
6	Invoking prior kowledge	121	06.08	12.1
7	Reading on	110	5.53	11
8	Questioning (word-related)	74	3.72	07.4
09	Analysing grammaticl form	71	3.56	07.1
10	Relating word with an Arabic word	51	2.56	05.1

It is clear from table 2 above that 'stated failure to understand a word' was the strategy which was used most. It makes up 327 (16.45%) of the total number (1989) of strategy use, 25.25% of the total number of text-related strategies, and 34.67% of the total number of word-initiated strategies (943). This high percentage reflects the subjects' poor vocabulary knowledge. The following table displays the frequency and percentage of strategy use of each of the two sections; that is text-initiated (word-related, sentence-related and text-related) strategies section and reader-initiated strategies section.

Table 03: Frequency and Percentage of Type of strategy Use

| Strategy Type	Frequency	Percentage
Text-initiated	**1295**	**65.10**
(i) Word-related	*943*	*47.41*
(ii) Sentence-related	*332*	*16.69*
(iii) Text-related	*20*	*01*
Reader-initiated	**694**	**34.90**
Total	1989	100

Results in this table reveal a higher use of text-initiated or top-down strategies (65.10%) than reader-initiated or bottom-up strategies (34.89%). As for text-initiated strategies, 72.81% of strategy use is focused on individual word focus such as questioning word meaning, analyzing grammatical form, then, to a rather low level comes the sentence-related strategies with only 16.69%. Finally, text-related strategies obtained only 01% of use.

Moreover, of the 1295 text- initiated strategies, 72.82% were word-related, 25.63% were sentence-related, and only 1.54% of the strategies were text-related. The above findings are graphically displayed in the following figures.

Figure 01: Percentage of overall Strategy Use
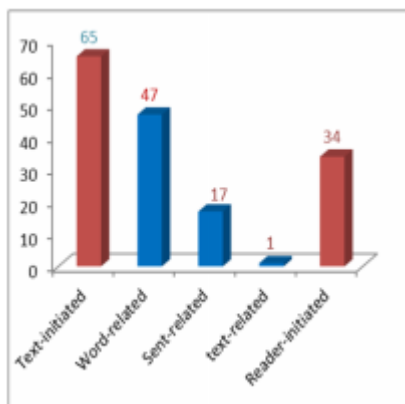
Figure 02: Percentage of text-initiated strategies
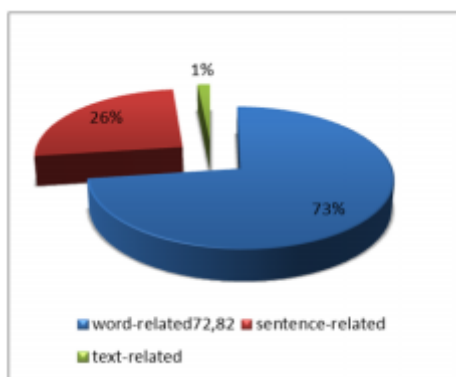
4.2. Qualitative Data

The twenty seven distinctive strategies that have been identified in the participants' think-aloud protocols holistically illustrate the efforts that these ESP readers have exerted in comprehending an English expository text. Moreover, the results indicate that the participants chose a variety of on-line strategies in order to make sense of what they read.

It is clear from the above tables that 'stated failure to understand a word' which is a problem-identification strategy (Olshavsky, 1977) was the strategy most used by the participants. It make up 16.45% of the total number of strategies used. This is but an indication of the much importance the subjects attribute to vocabulary while reading in English. Vocabulary was obviously a big obstacle to comprehension. Thus, they spent more time and demonstrated more strategy use in working out the meaning of words. This focus on vocabulary hindered the readers from paying more attention to the overall text for getting the author's view. Another explanation why the participants focused so much on vocabulary might be related to the process in which they learned English. English is taught on a bottom-up fashion and vocabulary is usually taught with meaning isolated from the text and sometimes on one-to-one translation base. The subjects' constant expressed need for a dictionary together with the high rate of relating the unknown word with a French word showed that the words were memorized for their own sake. The bottom-up learning process might condition the participants' way of approaching the English text.

Evaluating comprehension or monitoring comprehension is the second mostly used strategy. It makes 14% of global strategy use. This strategy is of particular importance for L2 readers; it is in fact seen as a hallmark of strategic reading (Casanave, 1988, and Block, 1992). It is one kind of metacognitive behaviour which involves the use of self-regulatory mechanisms which allow the readers to judge whether they have understood what they read and decide whether to take compensatory, corrective action when necessary. The participants constantly checked whether comprehension was taking place or not. In the latter case, they adopted repair strategies as rereading (12.92%), expressing need for a dictionary (08.69%), relating the unknown word with a French word (08.39%) invoking prior knowledge (06.08%), and reading on (05.53%). Other fix-up strategies with relatively lower percentages were also used. They involve questioning (03.72%), analyzing the grammatical form of the word

(03.52%), and guessing (02.52%). Together they constitute 12.36% of strategy use. The other remaining sixteen strategies, constituting 15.40% of strategy use can be grouped into those which obtained between 01.75% and 01.10% of strategy use (eight strategies), and those which obtained between 0.90% and 0.10% (eight strategies).

So, on the whole we notice that 41.61% of fix-up strategies are concentrated in five strategies and another 27.76% of strategies is widely dispersed between twenty strategies with percentages varying between 03.56% and 0.10%.   Overall, the results of think-aloud procedure revealed that the subjects engaged in three main categories of reading strategies as follows:

Figure 3: Overall Strategy Use

General Findings

The general findings of the study can be summarized in the following points:

    • Substantial verbalization indicating that the text was linguistically and cognitively demanding (consistent with prior research, Pressley & Afflerbach,1995)

    • The reading process mainly top-down rather than bottom-up reflecting low-proficiency level (Alderson, 1984; Bossers, 1991)

• Substantial comprehension monitoring by the use of fix-up (problem-solving) strategies

Implications: TAP as a teaching Strategy

The findings of this study may be used to determine the most efficient and effective instructional approach for reading improvement. We can think of the following classroom implications:

i. Reading strategies training should be integrated into courses in order to help students monitor their reading processes and improve their reading comprehension.

ii. Vocabulary instruction should be targeted for students who struggle. Certainly, low-comprehending students could benefit from interventions in all reading comprehension areas, but our results suggest they could benefit most from instruction in vocabulary building.

iii. Students, especially with poor reading performance can be taught explicit reading strategies through talking out loud about what they are thinking (TAP) when they encounter difficulty with a text.

iv. Emphasis on interactiveness of reading process, that is successful reading entails a balanced interaction between bottom-up and top-down processing skills.

Conclusion

The Strategies identified through the protocols were analysed in order to examine the reading behaviour of the subjects as they attempted to collectively comprehend the reading text. The analyses have provided clearer understanding on the types and frequencies of strategies used. This in turn revealed how the students went about comprehending the text when asked to think aloud during reading. Finally, the findings of this experiment should be viewed in the light of its limitations. First, although the technique is a widely used method to investigate the learners' reading processes, the

protocols are still limited in how much light they can throw on these processes. Second, as is the case of most process studies, it is difficult to draw strong generalizations due to the limited number of participants.

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APPENDIX I: TEXT FOR THINK-ALOUD
Therapeutic Uses of Toxins [i]

The powerful nature of toxin action historically made them the first line of attack in the search of effective vaccines, and this process still goes on today but with the advantage of a greater knowledge and the ability to manipulate their toxicity genetically. In addition, their potent actions have found widespread uses in other aspects of biology.

As the major effectors of bacterially induced host damage, toxins play a prominent part in both conventional empirical vaccines and the new generation of rationally designed vaccines. It was recognized early that inactivation of the toxic activity could produce highly effective immunogens

Table 7.9: Common targets attacked by several toxins

Target	Example
Membrane	Pore-froming toxins
	Phospholipases
	Superantigens
	E. Colistable Toxi n (ST)
Translation apparatus	Diphtheria Toxin (DT)
	Ps. Aeruginosa exot oxin A (ETA)
	Shiga Toxin
GTP-bindi ng proteins	Diphteria Toxin
	Ps. Aeruginosa exot oxin A (ETA)
	Cholera toxin (CT)
	E. col labile toxi n (LT)
	E. coli cy toxic necrtizing toxin (CNF)
	Bord. Pertussis toxin (PT)
	Bordetella dermonecrtic toxin (DNT)
	Cl. difficile and related toxins
	Cl. botulinumC3
	Staph. Aureus EDIN
Synaptosomal proteins	Cl. Botulinum toxins 'except C2 andC3)
Cl. tetani toxi n	

because inactivation did not destroy epitopic structure. Such chemically attenuated vaccines have served well in the protection against some diseases (e.g. tetanus and diphtheria). However, this has not been a universally successful approach, either because the induced immunity was poor and short lived (e.g. cholera), or because the vaccines are perceived to cause unacceptable side effects. A good example in this latter case is whooping cough, where the public

acceptance of the whole cell inactivated vaccine has not always been high. Several advances in vaccine technology have contributed to the new approaches being adopted to produce more effective and safer vaccines.

Knowledge about toxin structure has enabled scientists to identify which amino acids are involved at the catalytically active site (of intracellular toxins). These can be changed by genetic engineering to produce a protein that has only one or two amino acid changes but is completely devoid of toxin activity . Such a mutant protein is more likely for several reasons to be effective as a vaccine than a toxin with gross alterations. First, it is likely to be correctly folded into the native structure, and so display the epitopes that will trigger an immune reaction that will recognize the active toxin. Secondly , a correctly folded molecule is more likely to be stable and resistant to proteolytic attack in the host. Thirdly , in the case of intracellular toxins, a toxin that is only mutated in its enzymatic function will be able to carry out the first steps in intoxication, i.e. binding and cellular entry. This enables the immune system to process the protein more efficiently and better immunity is raised b y vaccination with whole toxin than just the active domain. In this regard, it is interesting that intracellular toxins as a group appear to very effective adjuvants.

This approach relies on fundamental knowledge about the toxins and other virulence determinants (e.g. adhesins) a bactirium makes. It is therefore possible to concentrate on only those proteins important in pathogenesis and thus potentially avoid the side effects of other extraneous bacterial products. This is being applied to pertussis toxin, where the further advantage of such an approach over chemical modification was identified. Formaldehyde inactivation of the toxin, which essentially acts to cross-link the protein, was shown to affect its structure and potentially mask or inactivate immunogenic sites, since t he untreated protein was more immunigenic than the chemically inactivated one.

Genetic manipulation of toxin genes is also being coupled to the newer delivery systems, using metabolically attenuated bacteria that can be given orally , e.g. arostrains of Salmonella that can only survive for a few generations in a host. Such systems have the potential advantage that the y have a greater likelihood of inducing protection and mucosal surfaces by administration via the oral route and also are more likely to be of use in the Third World, since an orally administered live vaccine will be cheaper and will not require continual refrigeration.

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[i] [Henderson, B et al. (1999). Cellular Microbiology: Bacteria Host Interaction in Health and Disease. John Wiley and Sons, pp305-307]