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# **Introspection as a Method of Identifying and Describing Competence in Reading Skills**

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## Abstract

Reading comprehension in English as a second language in the context of Iranian education system is not unproblematic. Hardly any studies have been attempted to investigate reading strategies and processes employed by novice and skilled readers through an on-line method of reading skills research in this context. The present study was thus undertaken to address the present need by employing think-aloud methodology to compare novice and skilled reading strategies. Therefore, a qualitative approach was taken to elicit as much information as possible for the purpose of identifying and describing competence in reading skills. The main research question addressed in this study deals with comparing strategy use of a group of novice second language EST readers studying academic English in Iran with another group of skilled second language EST readers from the same ethnic population but studying at the highest academic levels outside their mother land, viz. in Scotland. Several hypotheses were formed following a preliminary pilot study which included the following: a) there was a positive relationship between the number of strategies used by readers of each group and their performance on the TOEFL test; b) there are common areas in the readers' use of comprehension strategies which make the individual difference hypothesis in reading comprehension a debatable issue; c) the readers tend to follow an interactive approach to reading comprehension. Using an interactive model of reading seven categories of strategies were identified and classified. Non-significant correlation was obtained between number of strategies and language proficiency scores. Using a human information processing system, each reader's protocol was subjected to a detailed stage by stage analysis which supported the notion of the individual difference in reading comprehension. The readers also applied an interactive reading process to text comprehension.

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# Chapter One

## Introduction

# INTRODUCTION

## **1.1. Recent Trends**

The revival and reassessment of introspection as a useful method for exploring the curtailed-off aspects of the human mind in the last few decades has led researchers to tackle the issue more seriously than ever. Within the field of Applied Linguistics, and to the present writer's best knowledge, the study of reading comprehension has attracted the attention of introspectionist researchers more than other language skills. The reason for this may lie in the intricacies of reading comprehension and the curiosity of man to improve his understanding of it.

To unravel exactly what it means to comprehend a piece of text, cognitive psychologists like Wundt started to provide evidence about mental processes involved in reading comprehension in the late 1880s (Venezky, 1984). At the same time, the field of psychology was initiating a 'systematic experimental introspection' to get access to mental processes with the notion that observing psychological processes was accessible only under 'tightly controlled, laboratory-based studies' in which only trained subject-observers were utilized (Pritchard, 1990). Liberman (1979) reports that sometimes the observers had to practice up to 10.000 introspections before they were actually involved in a formal experiment. These painstaking efforts clearly reflect the importance of such mental accounts

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for the psychologists of the time. However, it did not take so long when the use of introspection as a scientific method was abandoned and disfavoured for few decades though research on reading comprehension was not halted.

One reason for its being disfavoured was the frequent-failure of such introspective results to be replicated in anyone else's laboratory (Hample, 1984). 'So introspectionism's elaborate training in observation sacrificed scope without securing scientific replicability' (P:142). Another reason for its collapse, as Liberman (P:320) contends, lies in 'the impact of Freud's revolutionary theories of the unconscious' which argued the existence of unconsciousness and exemplified that what is observable as consciousness constitutes only the 'tip of the iceberg' the main part of which is hidden under the water which he labels unconsciousness.

This was against the basic underlying assumption of introspective analysts of the time who believed that all mental processes were accessible to conscious observation. Reading research was naturally influenced by the change of the wave to the extent that no study of reading process using introspection was conducted during this time. The rise of behaviourism in psychology during the 1930s and 1940s put an end to the vulnerable introspectionism and a new era in examining and emphasizing *overt behaviour* of human cognition commenced. The denial of the existence of mind was of important concern for the early behaviourist

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psychologists such as Watson and McDougall (1929 in Radford, 1974). To this one may add a sincere devotion to objectivity in methodology.

Within the new behaviourism framework, introspection was regarded as something necessary and respectable by being treated as *verbal reports* (Radford, op.cit.). Thus, as Liberman maintains, 'they have absolutely no objection to using one bit of behaviour to predict another' (P:328). However, from an introspectionist perspective, what is important is not the observation of verbal behaviour or the idea that all we can see is behaviour but the subject's experience revealed through verbal reports and that these reflect 'the operation of an inner mental state' (Liberman, op.cit.; P:328).

Yet, in spite of the temporary abandonment of introspective investigation under the rigid influence of behaviourism of the time, a variation of the introspection paradigm called think-alouds was utilized during this time (for more information see Pritchard, op.cit.). The method of thinking aloud was invented by Duncker (1935) who stressed the difference between think aloud and introspection (the difference is discussed later in this chapter). As Newell and Simon (1972) maintain, the distinctive characteristics of these studies were the use of naive and untrained subjects and the fact that the subjects did not have to play the role of

subject-observer. It was rather the role of the researcher to infer the subjects' mental processes from their verbal reports.

The growth of cognitive psychology in the 1950s and 1960s resulted in a re-examination of the methodology followed by the early classical psychologist (Pritchard; op.cit.; Radford, op.cit.; Liberman, op.cit.). As a result, it was argued that the responses of highly trained subjects were artificial and thus less valid. Instead, the use of untrained subjects was advocated on the grounds that their verbal reports were of more importance for the cognitive psychologist.

However, since the aim of such psychological investigations into the reading process was not to find an immediate classroom solution, almost no attempts were made by the psychologists to draw upon their findings of the cognitive psychology and apply them to reading research in first and second language studies.

It was not until the late 1960s that the work of eminent psycholinguists such as Goodman (1967) and Smith. F (1971) opened new vistas into cognitively-based investigations of the reading process. Based on the theoretical notions of the time, early work in ESL reading assumed reading to be a passive, bottom-up process (Rivers, 1964) or the serial decoding of letters. Therefore, reading in a second language from the above perspective was treated and defined as a series of



decoding operations (Carrell, 1987). This period coincided with another important movement within the reading research domain and that was the employment of introspection as a reading process tool in first and second language investigations.

The pioneering work of Fareed (1971) in the first language and later on Hosenfeld (1977) in the second language marked the beginning of a renewed interest in employing one of the powerful instruments of mental research in classical psychology, that is, introspection.

Influenced by the early psycholinguistics reading research (Goodman, op.cit.; Smith, op.cit.), the late 1970s' works in ESL reading comprehension marked a radical change in its theoretical tenets wherein ESL reading comprehension was no longer beheld as a simple passive decoding process. It was rather regarded as an active top-down process which represents 'an attempt by the brain to find an existing knowledge structure to superimpose onto the incoming data in order to more quickly facilitate the assimilation of this new information' (James, 1987; P:178). The top-down approach regards the skilled reader not only as an active processor of textual information involving a process of predicting, sampling, checking and revising but also as employing his/her prior experience or background knowledge in understanding texts (Carrell). However, looking at the only reading strategy research (e.g. Olshavsky, 1976-77) in the second half of the 1970s which used introspection, there seemed to be no harmony between the new

development in the theoretical tenets of reading research and the use of introspection as a method of exploring mental events. Olshavsky, for example, used introspection to support her problem-solving theory of reading influenced by the work of Newel and Simon in which introspection was utilized to provide evidence for mental processes and strategies in solving logical and mathematical problems.

The resurgence of interactive theory of reading in the late 1970's and the early 1980's mainly by the work of Rumelhart (1977) in the first language and the articles of Carrell (1983) in the second language changed the conception of reading as a top-down strategy. The interactive models took bottom-up and top-down approaches as being complementary (Carrell, 1987; Carrell and Eisterhold, 1983; James) wherein efficient ESL reading comprehension requires one to implement both bottom-up and top-down processing operating interactively. The 1980's in contrast to the 1970's saw an increasing interest in the use of introspection into reading comprehension both in first as well as second language (e.g. Cavalcanti, 1983; Cohen, 1987; Rankin, 1988; Afflerbach, 1990), to name a few.

Centrally involved (among others such as sociology and sociolinguistics, information theory, the study of communication systems) in studies of ESL



reading in the 1980's and early 1990's is cognitive psychology (cf., Long and Richards, 1990; Connor, 1987; Hosenfeld; Cohen and Hosenfeld, 1981; Baker and Brown, 1984; Just and Carpenter, 1984). It is nowadays generally accepted that the field of linguistics and more specifically studies of ESL reading cannot provide fruitful findings if they are detached from the findings of cognitive science (O'Malley and Chamot, 1990). Contending against autonomous linguistics and cognitive psychology, Baker and Mos (1983) maintain that the study of language must be essentially inseparable from cognitive considerations.

The collaboration between reading research and cognitive psychology has resulted in changes in applied language studies in the last two or three decades. More representative than others are shifts from product to process research (Long and Richards). Many reading scholars have convincingly confirmed that findings of product-oriented reading research are less illuminating in terms of explaining the cause of reading problems (Garner, 1982). In fact, recent thinking emphasizes the process of discovery, adaptation and enquiry, based on the belief that education in general is concerned with unexpected rather than predicted outcomes. A general view in this regard indicates that the product-oriented approach deals with what is to be learned rather than showing how something must be learned.

Alderson and Urquhart (1984) rightly argue that by distinguishing and characterizing the processes and strategies which readers utilize we may find general elements across different texts which may allow us to improve their reading. The value of process research, as added by Alderson and Urquhart, resides in the notion that our attempts should be targeted toward an understanding which may lead to the possibility of distinguishing the processing of successful and unsuccessful readers. In fact, it is here that the possibility of teaching strategies or process components of successful readers to unsuccessful ones may become constructive.

The endeavour to understand the nature of reading, its context, and developmental stages has resulted in an increasing interest in employing descriptive reading methodology in first and second language studies during the last two decades. Jacob (1987) reasons that this tendency is generally rooted in an increased use of qualitative or ethnographic research methods in psychology, education, communication, and discourse analysis. On the other hand, Taron (1982) attributes this shift to the distorting effects of the experimental research setting on the data. Moreover, Seliger and Shohamy (1989) argue that the data elicited from controlled, artificial experimental settings may be different from those produced in natural settings. More specifically, among other phenomena one may consider the following: the product-orientedness of some experimental studies which rely on

standardized scores or ‘scores on a small number of questions following a reading passage’ (Connor, op.cit.; P:11) which are collected after reading and which are dependent on memory (Baker and Brown); their failure to go beyond the results of statistical tests (Fasold, 1982 in Connor); and more importantly, their failure to account for reading processes (Alderson, 1990).

## **1.2. Defining Important Terms**

### **1.2.1. Introspection**

A psychology dictionary defines introspection as ‘1. the act of examining one’s own thoughts and emotions by concentrating on the inner self; 2. a tendency to look inward and view the inner self’ (Glanze et al., 1990; P:644). However, as Pepper (1918) explains, *process description* of mental events is the unique quality of introspection. To get a better understanding of the term introspection, one needs to look at different types of introspection.

Searching into the related literature, one finds few traces of agreement among the researchers as to where to make a borderline between different types of mental states. For example, Ericson and Simon (1980) lament the lack of clear guidelines to distinguish introspection from other numerous forms of verbal reports. However, the core of all mental states studies, as agreed by introspective researchers, is the notion of *verbalization*. That is, the subject’s primary task, as



has been argued, is to produce some verbal reports of his or her 'stream of consciousness'. Ericson and Simon distinguish two basic types of verbalization, mainly, concurrent verbalization and retrospection. By the former, they contend, subjects must do two things: performing the task being presented to them and verbalizing. Thus, 'if information is verbalized at the time the subject is attending to it, we will label the procedure *concurrent verbalization*' (P:218) or what some researchers have called introspection (see, for example Pepper; Sternglass and Pugh, 1988). Therefore, in concurrent verbalization or *thinking aloud*, thoughts are revealed verbally without the subject's attempt to control, direct or observe them beyond certain instructions given by an investigator to a research informant. The respective immediate data are, thus, 'unanalyzed and without abstraction' (Cohen and Hosenfeld, op.cit.; P:286). However, if a subject is required to report cognitive processes that occurred at an earlier point in time, then the procedure is called *retrospective verbalization*<sup>1</sup> (Ericson and Simon, op.cit.).

Introspection based on the above classification falls in the category of thinking aloud and is as immediate as thinking aloud. However there is a difference between introspection and thinking aloud. The difference lies in the fact that in

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<sup>1</sup> Sternglass and Pugh refer to Husserl's distinction between retention (i.e. immediate sensory traces, what today is identified with perception) and representation (i.e. experience recalled over a greater distance of time). The distinction lies in the time interval of experiences perceived and recalled immediately and the ones which are recalled later. Sternglass and Pugh takes retention as identical to introspection while equalizing representation to retrospection.

the former the subject is required to report on processes and strategies and theorize about them, thus carrying 'an additional burden' on his\her cognitive processing, while in the latter case the subject performs the same task but theorizing about the reported processes is left to the researcher (Afflerbach and Johnston, 1984).

### 1.2.2. Strategy

'Rubin writes another very influential article on this subject. In that article, Rubin examines the 'strategies' that good learners use. Her article begins by stating, not that 'strategies' are unlearnable, unteachable 'forms' or 'levels' of 'processing', or that they are 'overall characteristics of an approach', but rather that 'strategies' are 'techniques and devices' (P:43), that they are 'what ... successful learners *did*' (P:42), and 'what [a] good learner *does*', (P:43)... But in its actual descriptions of specific 'strategies', Rubin's article says things such as that a good learner '*is a willing guesser*', that a good learner is '*willing to appear foolish*', that a good learner '*has a strong drive to communicate*' and '*is prepared to attend to form*'. And 'being willing' or 'having a drive' are certainly not techniques or devices. So we find something of a discrepancy' (Stevick, 1990; P:144).

The above critical comments by Stevick clearly reflect the typical ambiguity of the concept of 'strategy' utilized by different second language researchers. Bialystok (1984) distinguishes two different approaches concerning the definition of strategy employed in the second language literature; 1) classifying strategies according to function (for instance, according to taxonomies of communicative strategies and/or learning strategies); 2) defining the term by comparing and contrasting it to other similar concepts (e.g. distinguishing strategy from process). She states that



the first approach is problematic due to the numerous overlaps strategies may have with each other. However, regarding the second approach, various definitions have been proposed. Seliger (1984; P:38), for example, distinguishes between *tactics* and *strategies* wherein tactics consists of a wide range of behaviours or learning activities that depend on such factors as 'environment, age, personality, affective constraints, and first language'. Strategies, on the other hand, are invariant and universal. 'They cannot be taught, nor can they be acquired in any way' (P:41).

Blum and Levenston (1978) argue that the distinction between the terms 'strategy' and 'process' is not clear in the literature of second language studies and that one sometimes finds that *strategy* is being used interchangeably with *process*. They propose a time-constraint dichotomy in which strategy should be used when referring to *single cases* while process refers to a number of operations that have taken place. The distinctive feature in this classificatory view is the one in which *strategy* 'refers to the way the learner arrives at a certain usage at a specific point in time, and *process* refers to the systematic series of steps by which the learner arrives at the same usage over time' (Blum and Levenston, op.cit.; P:402).

This study sees strategies of reading comprehension in the context of English as a second language as events related to 'certain kinds of mental activity' (O'Malley

et al., 1985) which must satisfy 'the criteria of *problematicity*, *consciousness* and *intentionality*' (Bialystok, op.cit.; Faerch 1984). Problematicity refers to the notion that strategies are used when problems in comprehension are detected by the reader. The consciousness criterion refers to the notion that the reader is aware that the strategy is being utilized for a particular purpose. Intentionality relates to the control the reader shows over the strategies being used. This also refers to the reader's particular strategy selection from among a range of choices to achieve certain effects.

### **1.3. Statement Of The Problem And Realization Of The Need**

The pervasiveness of English as the 'language of science' used overseas in educational institutions is an indisputable reality. In Iran as well as in many other developing countries the great majority of the science and technology written materials are in English. As Strain (1971 in Hitchcock, 1978) asserts, 'its most valuable resource appears to have been the wealth of scientific and technological knowledge that now exists in English' (P:11). To nations which, like the present Iran, have set their views on industrialization and the economic and social benefits that it represents, this particular knowledge is honoured highly. Mass education is a recent phenomenon in Iran. The student population which was 5,000,000 during 1972/73 (Hitchcock, op.cit.) has reached the ceiling of 20,000,000 in 1995<sup>2</sup>.

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<sup>2</sup> The figure did not include students enrolled in Literary Corps schools or literary classes (Keyhan Havai, 1996).



During the last decades or so universities in Iran have been growing at a rapid pace. Since the establishment of the Open University in 1981 and tens of other related faculties throughout the country, and an extraordinary increase of enrolments which continue to climb rapidly<sup>3</sup>, the need for technical and scientific English has been growing.

One problem within the context of the Iranian English language learning/teaching policy is one of low English language reading ability. An important cause for this among other things (e.g. inappropriate reading materials, unfitted English teachers and unsuitable syllabus factors) is lack of a good knowledge about reading strategies and processes used by the novice and skilled second language readers. This is partly due to lack of systematic research into the nature of L2 reading strategies by means of sophisticated techniques which may provide insights into diagnosing language reading deficit. Assessment of the reader's language problems with text and the respective processing strategies does not go beyond insights gained by the language teacher through the pseudo-multiple choice tests of reading comprehension which at best provide one with reading comprehension production rather than processes. This has led to a situation that has put the novice Iranian language learner into facing an almost constant comprehension

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<sup>3</sup> According to the recent statistics of the Iranian ministry of culture and higher education (Ashena, 1995), the state universities as well as Open universities are giving service to one million students which indicate a huge demand for technical and scientific resources.



downfall. The least consequence of this for the student science community is that not only does L2 reading comprehension suffer but also the English language curriculum at the university level cannot benefit from its investments in teaching English particularly with the last decade increase of student population (each year millions of students graduate from high school with a dormant knowledge of English).

The importance of a systematic analysis of reading strategies used by novice and skilled reading comprehenders is firmly advocated by reading comprehension scholars (e.g. Hosenfeld, 1977). The analysis permits the language teacher to have a realistic view about his/her students' weak and strong points in reading comprehension. So the need arises from the fact that studying what strategies novice readers do have available and how these compare to expert strategies would seem to be a vital first step in building a sound program of instruction (Scardamalia and Bereiter, 1984). There is evidence that skilled readers have special strategies that they can bring to bear in cases where comprehension is difficult. This need is realized and has been the major force behind this undertaking.

#### **1.4. General Overview**

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The thesis is divided into three parts. Part one comprises the first two chapters: introduction and literature review. Part two is mainly devoted to two main chapters; a chapter on theoretical and methodological basis of introspection, and of reading comprehension as viewed in the study, and a chapter on methodology. Part three includes the last two chapters viz. results and discussion, and conclusion.

# Chapter Two

## Literature Review



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# EST READING RESEARCH

## 2.1.1. Introduction

The upsurge of interest in research on second language reading over the past few decades has increasingly contributed to our knowledge about this highly complicated human cognition process. In spite of huge bulk of research done on reading in English as a second/foreign language, far fewer studies appear to have been conducted to examine reading in the context of English for Science and Technology (EST) (Ulijn and Pugh 1985; Eskey 1987b). Yet, the influential contribution of the former to the latter can hardly be ignored. There are indeed areas of concern for a given second/foreign language reader, be he a general or EST reader. The three most important recurrent themes in reading comprehension for meaning deal with topics on background knowledge, examining the role of syntactic and lexicon knowledge in text processing and finally research on strategies and processes in reading comprehension (Palincsar and Brown, 1984). In contrast, though, the number of studies employing introspection into EST reading comprehension research is far fewer. This section, therefore, covers a review of studies using introspection in both EST as well as English as a Second Language (ESL) reading comprehension research.

### **2.1.2. Schematic-Oriented Studies Of EST Reading**

Of central themes in EST reading is the consideration of background knowledge or what William Grabe (1986) calls a 'critical mass' and more technically 'schemata'. Comprehension as Eskey (1986) maintains, 'is always directed and controlled by the needs and purposes of an individual and therefore crucially depends on that individual's having acquired an adequate background knowledge on the subject of his enquiry' (P:6).

The role of background knowledge in processing textual materials has been a recurring theme in research into second/foreign language reading (Carrell 1983; Carrell and Eisterhold 1983; Cziko 1978, 1980). Within the domain of English for Science and Technology, Ulijn and Strother (1990) examined the extent to which background knowledge affected syntactic analysis in reading an EST text.

According to their results, schemata did maximize the comprehension of a group of novice and expert computer science students, but it did not decrease reading time. Ulijn and Strother also report a schema-oriented study by Fincher-Kierfer, Post, Greene and Voss (1988) who demonstrated that subjects with background knowledge of domain-related texts used more efficient comprehension strategies than did subjects without such schemata.

Alderson and Urquhart (1985) in an attempt to determine the effect of students' academic discipline on their performance on English for Specific Purpose (ESP)

reading tests observed an interaction between background knowledge and linguistic proficiency. In different studies at Aston University and the University of Lancaster, four groups of students studying in four content areas: Development Administration and Finance (DAF), Engineering (ENG), Liberal Arts (LA) and Science and Mathematics (SM) were each given five texts in the respective fields. The results of the study revealed that the students performed equally on direct and overview questions when they were familiar with the content area. However, when this familiarity was lacking 'they could still answer direct questions, but their ability to answer overview questions was greatly reduced' (P:203).

Criticizing Alderson and Urquhart's usage of cloze tests in determining the role of background knowledge in comprehending academic text books, Shoham et al. (1987) investigated the relevance of subject-specific reading passages to performance on reading comprehension tests for advanced English as a Foreign Language (EFL) students. 185 Israeli EFL students from different disciplines, namely, Science and Technology, Biology, Humanities and Social Sciences were administered reading comprehension tests. The results revealed that although students of Science and Technology as well as Biology performed better on subject-specific test passages, the Humanities and Social Science students did not perform better on their subject-related passages considered to be relevant to their disciplines. A further statistical analysis of the percentage of students in



each discipline who achieved the highest scores on their respective discipline-related reading comprehension texts revealed that 55% of the Biology students received the highest scores, while for the rest this percentage decreased to 39%. They conclude, therefore, that the subject-related property of a text does not appear to facilitate comprehension for the respective readers better than texts related to other disciplines. However, a more detailed analysis of the above results showed that performance on subject-related text depends on level of reading competence. In fact, more proficient readers (e.g. Biology and Social Science and Technology) benefited more from subject-oriented reading passage on the comprehension test than did the less proficient readers (e.g. Humanities and Social Science students).

In a report on the reading processes of seven research physicists, based on data gathered from interviews and observations, Bazerman (1985) examined two themes related to the reader's purpose and background knowledge. The first theme pertains to the researcher's own need to accomplish research and his understanding of the field. This shapes the reading process, Bazerman contends, as well as the meaning carried away from the professional literature. The second theme concerns the relationship between purpose and schema. In this view, the reader's schema includes active purpose and purpose is shaped by schema. These two provide a framework against which the reader comes to understand an article. Tracing what actually happens when native speaker and non-native

speaker users of instructional material attempt to carry a task to completion, Mohammed and Swales (1984) conducted an experiment with a sample of 12 subjects both native and non-native speakers of English with Science and Arts backgrounds. Having videotaped the sessions, they asked the subjects to comment on their strategies as it was being replayed to them. With regard to speed of task completion and English proficiency, the results indicated that 'science background is a greater facilitator of efficient completion than very good knowledge of English' (P:211). This was due to the fact that the 3 non-native students of science and Engineering courses adjudged to have the weakest English proficiency completed the task sooner than the 2 native speaker Art students. Mohammed and Swales, hence, hypothesize:

'i. There is a *threshold* level of English proficiency without which such reading tasks cannot effectively be done, and that this level may lie somewhere around ELTS Band 5. ii. Above that threshold either *field-familiarity* or, more likely, familiarity with the genre of technical instructions is the most important predictor of success'. (P:211)

However, other studies have shown that the role of background knowledge in facilitating text processing is not always held constant in the experiments (Ulijn 1984) and may be counter-productive unless there is 'a good fit between existing knowledge and text information' (Lipson 1984; P:763). As regards the former, Ulijn and Kempen (1976 in Ulijn), report on an experiment where a group of technologically naive students were asked to render French technical instructions



for use. The results indicated that syntactic knowledge played a role in correct translation.

Given the latter, Lipson's studies suggest that some less-skilled readers despite their inaccurate knowledge and inappropriate use of their knowledge are unwilling to give up that knowledge in favour of text information. 'Indeed, they appear more likely to distort the text information to align it with their previous ideas' (P:763).

A recent illuminating study in ESL reading research covering almost all component sections in this chapter was conducted by Bernhardt (1991) who used recall protocols as information in analysing ESL reading comprehension problems of a group of German and Spanish learners who read business and newspaper texts. Using a heuristic containing 6 features- three text-driven (that is, word recognition, phonemic/graphemic decoding, and syntactic feature recognition) and three knowledge-driven factors (including intratextual perception, metacognitive, and prior knowledge), Bernhardt analysed the data within an interactive model of reading. The results obtained from the German readers reading a business letter revealed that, in general, prior knowledge did not play a very significant role in the students' recall. As Bernhardt observed: 'a lack of prior knowledge may have accounted for more of the readers'



comprehension problems' (P:141). However, she then contends that the notion that background knowledge always facilitates comprehension is totally invalid.

The results of another recall protocol analysis with another group of high school readers of German reading a newspaper article almost confirmed the conclusion stated earlier. In fact, as Bernhardt stated, non-specific and unclear background knowledge when inappropriately applied would impede rather than facilitate comprehension.

### **2.1.3. Syntactic-Oriented Studies Of EST Reading**

Research on the linguistic aspects of reading in a second/foreign language has shown that linguistic knowledge is an important factor in the second language reader's ability to tackle reading comprehension problems (see for example, Clark, 1979 and Cooper, 1984). Within the domain of EST reading comprehension studies syntactic problems are reported to be a frequent problem.

An EST syntax-oriented study done by Aronson-Berman (1978 in Ulijn 1980) highlighted that syntactic simplification facilitated text processing for a group of Hebrew-speaking college students who showed a significant difference in success in comprehending 2 versions of an English text, one syntactically simplified, the other not, but with a similar content and vocabulary.

Examining whether syntactic rewriting does affect EST text comprehension, Strother and Ulijn (1987) argue that based on their findings, complexity of syntax does not significantly make an EST text more readable. However, they find that textual and lexical rewriting might contribute to text comprehension. Research into the use of articles and verb tenses in ESP by Selinker and Trimble (1974 in Cohen, et al. 1979) shows that because use of articles and verb tenses in ESP texts reflects generalization and rhetorical or organizational decisions made by the author about a piece of prose and is most often not apparent as such to the non-native reader, they become hurdles to text processing among EST non-native readers.

Later Trimble and Trimble (1985) expounded the relationship between what they called presuppositional information problems in article use and EST students' failure in using strategies to relate this information to what the writer of an article presupposes his/her reader may know about the special uses of the definite article. They classify the special uses of the definite article as 'apparent inconsistency of use' and 'basic rule violation'. By the apparent inconsistency of use is meant the mixing of rule-based uses of the definite article with its complete omission. This inconsistency of use most often happens in technical manuals and when the 'rhetorical function of instruction' is utilized. The reason for this inconsistency of article use, they assume, is that firstly the writer primarily writes for native speakers and secondly s/he prefers to present the

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information in 'note form' so that the writer presupposes that the reader is familiar with note form and is able to process the text and understands the discourse information, filling in the required data from his/her experience.

They then present an example taken from an instruction which says (*Open valve located at bottom of filter to full open position. Repeat valve should be opened to full open position before starting engine*). It is argued that the reader can only understand when s/he can recognize the embedded short relative clause (so that 'open' is understood as a verb) and grasp the omission of the definite 'the' before 'filter'. In the case of the second sentence above, one has to be competent enough in reading English to know that the phrase 'repeat valve' is not acceptable unless one presupposes that the sentence is read as 'Repeat! the valve...'. The authors conclude that many EST non-native readers cannot grasp such omissions and fail to understand the discourse simply on the grounds that they are in habit of reading linearly and of using word for word strategies and not word groups strategies which allow them to detect meaning via syntactic and lexical combinations.

Regarding the article function in EST discourse, Huckin and Olsen (1984) demonstrate that the definite article is used to signify that a noun or any noun phrase used with it is *unique*. They then describe three types of uniqueness: inherent uniqueness, contextual uniqueness, and implied uniqueness. Inherent



uniqueness refers to the uniqueness which exists in the nature of the noun as in 'generic nouns'. Contextual uniqueness comprises 1) previous mention of a noun, 2) a noun with a following modifier and 3) shared knowledge between the writer and reader. Given this third type of contextual uniqueness, Huckin and Olsen maintain 'sometimes the writer uses a noun or noun phrase that has only one referent and thinks that the reader knows about this uniqueness of reference. But by implied uniqueness is meant cases where 'the writer wants to imply that a noun or noun phrase has a unique referent even though the reader may not know of this uniqueness' (P:183). Ulijn (1984) also relates some reading problems of Japanese, Arabic and Russian speaking scientists and engineers because of the lack of definite articles in their respective languages.

Tyma (1981, in Trimble and Trimble, op.cit.) suggests that a demonstrative adjective provides readers with signals to employ look back strategies to the preceding context to find important information. In Tyma's view the definite article does not imply such urgency.

Bhatia (1987) examines the effect of syntactic discontinuity on the process of reading legislative documents of second language learners with less linguistic proficiency. The results of his two experiments showed that the above learners failed to use strategies to process components which were rendered discontinuous by the insertion of 'long qualificational sequences'. The learners

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used a 'unidirectional strategy' to fill a gap imposed by the processing of discontinuous constituents. That is, instead of employing the context of what precedes the gap and what follows it, the participants used either 'anaphoric' or 'cataphoric' strategy to accomplish the task. Bhatia's experiment stresses that syntactic processing is an important part of text processing particularly for less proficient readers of legislative writing. Studies on frequency counts of verb tense have revealed that the passive form of the verb constitutes one of the most salient syntactic properties of the EST genre (Robinet 1980 in Tarone et al., 1981). Due to its extensive use in EST texts and its inherent difficult processing for less proficient non-native speakers of English, stress has been laid on its extensive handling in class situations (Warren 1981 in Ulijn, op.cit.). However, the study of Tarone et al. on two astrophysics journal articles and the one done by Wingard (1981 in Ulijn, op.cit.) on verb forms and functions in six medical texts have interestingly documented that active verbs outnumber verbs in the passive. As Ulijn contends differences are more a question of variation in frequency from science field to science field, from text to text within a science field and within a science text.

Numerous studies have suggested that compound nominal phrases (CNP) or what Palmer (1968; P:72 in Salager, 1984) calls *pliologs* present serious problems to EST non-native readers and are hurdles to employing successful reading comprehension strategies (Williams, 1985). The rationale underlying



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CNPs is the notion of economy (Salager, op.cit.). In fact, these strings of syntactic elements function more economically than a bunch of function words which are more longer and express the same meaning as the respective compact forms. CNPs are given much attention in the professional literature for some important reasons. Hence, as Williams maintains, the non-native reader has not internalized a set of 'recovery procedures', and therefore cannot use strategies to transfer them to operate on English CNPs. Secondly, they are difficult to translate literally to the extent that even native speakers of English often find them to be confusing. Thirdly, CNPs contain an extremely wide variety of function and form (see Sager et al., 1980 for a detailed classification of CNPs' categories of forms and functions). Renkema (1984) while emphasizing the function/s of language for specific purposes (LSP) takes a linguistic view as to Dutch officialese and compares three types of bureaucratic languages (e.g. daily newspapers, weekly newspapers and popular scientific prose) in terms of linguistic frequency of nouns and verbs. The hypothesis was that bureaucratic languages, due to their more 'matter-of-factness' have more nouns and fewer verbs. His results were supportive of the hypothesis laid down. Furthermore, it was found that with regard to infinitives used as nouns and verbs, popular scientific prose tended to be less different from bureaucratic language than newspaper language.



Tackling EST students' intermediate reading skills at the basic decoding level and skills in using non-verbal forms (graphs, diagrams), Foley (1985) assessed three different groups of EST non-native speakers of English at different times and in various settings through a two-stage cloze test. The result of his first study in 1978 revealed that the subjects had problems in using their knowledge of the structure, lexis and cohesive devices necessary to pick up the contextual cues particularly in function words and rhetorical devices.

The result of the second study in 1978 with a group of 93 Arab students showed that the subjects had serious problems with syntactic patterns and the lexis. The result of the third study conducted in 1982 with a group of EST Singaporean university students showed that 48% of the students needed help to develop their reading skills in English. In all these studies, Foley observed that the use of non-verbal forms in reading comprehension was often a major problem for some students who appear to be able to use text decoding strategy with ease but do not know how to use it functionally when diagrammatic material is involved.

Also, part of the results of the study undertaken by Bernhardt reported earlier in previous section dealt with syntactic problems of ESL readers. Bernhardt observed that syntactic errors permeated the recalls of subjects. The subjects were found to have problems in deciphering 'minor syntactic structures' such as misinterpreting singular nouns as plural. With the business letter text, syntactic

feature recognition problems were found to be a major source of comprehension failure while for the newspaper article the influence of prior knowledge helped the subjects to decipher syntactic relationships in sentences.

#### 2.1.4. Word-Oriented Studies Of EST Reading

Cross-linguistic studies of reading of foreign and technical texts highlight the important role that lexicon plays in EST text comprehension (Cohen et al., op.cit.; Ulijn op.cit.; Albert-Dewolf, 1984; Mohammed and Swales, op.cit.).

Ulijn reports that by the development of science and technology 4000 new terms are added each year to the language of science dictionaries, hence requiring the applied linguist to face two options either 'make these new words as language specific as possible, using common language words and hence creating polysemic associations or make them as international as possible with a kind of controlled language supervised by international standardization committees. Although the second option is held to be preferable to the first one for the non-native speech community, the increasing scale of the problem requires one to devote more effort and attention to this particular part of reading comprehension for specific purposes.

In a similar vein, Cohen and Fine (1978) found that their subjects had problems with words denoting conceptual meaning which interfered with their understanding of the passages under investigation. Although the subjects were

allowed to use a bilingual dictionary to find the difficult words, they sometimes misread words for instance, one read 'economic plan' as 'economic plane' which distorted the meaning of the text as a whole. Furthermore, the students had difficulty with words which were of metaphoric nature and had more than one meaning. An example is 'economic gap' wherein gap refers to a conceptual gap rather than a geological one. Cooper maintains that his English for Academic Purpose (EAP) 'unpractised' Malay readers were severely disadvantaged by their deficient knowledge of vocabulary. They also failed to understand the semantic relationships between words. Cooper's findings and those of Strother and Ulijn are in symbiotic relationship in that both studies stress that for EST students, the lexical area should be focused on most, particularly the semi-technical vocabulary. Cooper also found that the unpractised EAP readers showed weaknesses especially in understanding affixation and a range of syntactic features.

Albert-Dewolf states that scanning foreign scientific articles demands knowledge of foreign terminology as well as a sound realization of the most productive morphological and morpho-syntactic term-formation processes which eventually assist the EST reader to decode the foreign terminology.



According to Yorio's results (1971 in Ulijn 1980) of a questionnaire distributed among various groups of ESL students, vocabulary appeared to be a more serious obstacle in processing a text than grammar.

Wiess (1985) designed a reading study to answer the question of the contribution of the following to reading comprehension in English as a second language among university students: knowledge of English vocabulary; knowledge of English syntax; knowledge of English cohesive devices. First year undergraduates in science and technology field were administered tests in vocabulary, grammar, cohesive elements (that is, anaphoric references and connectives) and overall reading comprehension. The results showed that vocabulary has a 33% better potential for predicting ability on a reading comprehension test than the other variables; cohesion rates 11% and grammar only contributes 3%. Vocabulary recognition is held to be a better factor which discriminates between group ability.

This view is shared by Laufer (1989) who asserts that text interpretation is dependent mainly on the lexical and conceptual cues. In an attempt to measure the relationship between the number of words understood by a reader in an academic text and the quality of comprehension of the text, Laufer posited the following question: 'What percentage of word tokens must be understood to ensure reasonable reading comprehension of a text?' One hundred first year

university students from various departments, native speakers of Hebrew and Arabic who were taking a course in EAP were used for the experiment. The results showed that lexical knowledge of the text greatly affected reading academic prose. Laufer then claims that in order one to be a successful reader one needs to know a lexical coverage of 95% and above, that is 95% of the text's words should be familiar to the reader. Laufer's study showed that when this coverage was below 95% comprehension was impaired, thus providing evidence for Deville, et al.'s (1985) and Ostyn and Godin's (1985) claim.

In the discussion of the impact of vocabulary on reading comprehension of the learners of German and Spanish, Bernhardt identifies that the abstract and vague vocabularies in the business letter had a profound negative influence on the readers' comprehension especially vocabularies which were not explicitly explained in the text. The problem was reflected in the subjects' recalls in which few such vocabularies were reported.

### **2.1.5. Introspective-oriented Studies Of ESL Reading Strategies**

The pioneering study of Hosenfeld (1977) dealing with finding out what successful and unsuccessful language learners do to assign meaning to printed texts opened new vistas in introspective studies of this sort and left a great impact on reading research investigations. A group of 40 foreign language students (that is, American students enrolled in level two French, Spanish and

German classes in urban and suburban high schools in western New York) were selected for the study, half of whom scored high on the MLA-cooperative Test of Reading proficiency while the rest scored low on the same test. After a preliminary practice session, subjects were asked to think-aloud as they read a French text. Whereas some students self-reported in English without training, others needed several practice tasks. In order to categorize the strategies utilized by the subjects, 'reading maps' were developed which provided 'graphic, visual portrayals of an individual student's reading strategies, underscoring similarities which existed among the strategies of successful readers and among the strategies of unsuccessful readers' (P:123). Reading protocols were then coded into reading maps.

The results showed strategy differences between the successful and non-successful students. The successful readers read in rather broad chunks (or phrases) and keep the meaning of the text in mind, disregard words that seem to be insignificant to the total meaning of the text, make full use of the context to get the meaning of an unknown word, search for the meaning of the unknown word in the back of the book as a last resort, leave the word after several unsuccessful attempt and have 'a positive self-concept' as a reader.

The unsuccessful reader, on the other hand, loses the meaning of the sentences as soon as s/he decodes them, reads in short phrases, skips words as unimportant



since s/he gives the same weight to each lexical item in the text and cannot distinguish the contribution of each word to the total meaning of the text, looks up an unknown word in the glossary and has a 'negative self-concept' as a reader.

In a retrospective investigation on Jewish students' handling of specialized English discourse conducted by Cohen and his colleagues (1979), students from different ESP disciplines mainly Genetics, Biology, History and Political Science were given reading passages relevant to their field of study. To elicit information, different approaches were utilized for the four groups of students. The results across all four studies revealed that despite different procedures and approaches, the four studies produced an amount of similar data. The problematic areas for the above students are reported to be heavy noun phrases in various syntactic functions (e.g. subject of the main clause, object of the preposition) and syntactic markers of cohesion. They also found that across all four of the studies the learners were not able to understand the conjunctive words of cohesion.

This last result supports Cohen and Fine's exploratory study in which ESP non-native speakers together with native speakers of English received three levels of questions, mainly, macro, micro, and vocabulary. The results revealed that non-native speakers did not clearly perceive how to use reading strategies to integrate

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material across paragraphs (macro level) nor were they able to understand the relations within the text (micro level).

Using the strategies of successful foreign language readers, and in order to examine whether unsuccessful readers may acquire the strategies of successful foreign language readers, Hosenfeld (1984) ran an experiment with an American high school student called Ricky whose second language was Spanish which was taught by an audio-lingual method including memorization of dialogues and manipulation of pattern drills. The data were collected in the school cafeteria during the student's regulatory scheduled class and in his classroom after school.

One researcher collected the data, with a graduate student helping with the remedial sessions and videotaping. The data were collected during five half-hour sessions. The first session dealt with the diagnostic phase followed by four instructional sessions. The data were of a think aloud type. Data analysis consisted of: a) the qualitative analysis of transcribed think aloud data gathered before and after instruction; b) the developing of two essays which described the reader at the two different stages.

After going under some remedial sessions, Ricky is reported to have guessed the meaning of a new word by using '(1) known words in sentences, (2) his knowledge of cognates, (3) his knowledge of the world, (4) context and (5) his knowledge of grammar' (P:242). However, as Alderson and Urquhart (1984)

contend, Hosenfeld's work only deals with situations when the reader faces an unfamiliar word. They contend that her study does not show what happens when the reader faces an unfamiliar syntactic construction and when various kinds of texts are used (that is, literary texts vs. language-teaching texts).

Cavalcanti (1983) examined reading processes of an adult Spanish non-native speaker of English as compared with L1 reading through a pause protocol which required the informant to verbalize whenever a pause occurred in his reading process. Each pause in the protocol was approached as a potential problem and two categories were selected in which types of problems and types of strategies were included. She used title study, interventionist procedure (or what she calls thinking aloud) and retrospection as the main methods of the study. The title study required the reader to look at the title of the paper and say what he knew about it and what he thought the paper was going to be about. The interventionist procedure consists of a set of questions used to interrupt an ongoing activity to ask the reader to do immediate retrospection about what he was doing at the moment he was stopped. The retrospection accounts refer to the brief summaries the reader was asked to make at the end of the paragraph.

Analyzing the protocols, she explains the strategies under the following headings: a) the reciprocity of perspective for orientation purposes; b) normal forms for prediction purposes; c) the etcetera principle for filling in meanings

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throughout and after the interaction; d) the retrospective-prospective sense of occurrence for connecting purposes; e) descriptive vocabularies as indexical expressions for going beyond the information given, that is, the attribution of meaning beyond surface form. The results showed that overt occurrences of strategies were not related to comprehension problems. Cavalcanti assumes that this may be due to her subject's adequacy in reading. The study also supported Faerch and Kasper's notion (1983) that advanced readers in their command of procedural knowledge (knowledge which relates to how to do an action *per se*, such as knowledge of how to tie a shoe lace) may have ways of obscuring strategic competence such as hiding problems in comments.

Block (1986) undertook a detailed description of the reading processes utilized by a group of ESL students designated as nonproficient readers and a group of English native speakers through the think-aloud technique. Nine students were selected, six (three native speakers of Spanish, three native speakers of Chinese) of whom were enrolled in reading classes for ESL students and three of whom were enrolled in college reading classes for native speakers. To avoid frustration caused by the experimental text, the subjects were given two cloze tasks using passages selected from an intermediate-level ESL textbook. One of the texts was translated into the first language of the ESL students to specify if the ESL participants were competent readers in their first language. Therefore,

the ESL readers read one text in their first language and one in English, whereas the native speakers read both texts in English.

Two passages were selected from a textbook used in an introductory psychology course which students frequently take in their freshman year. A triangulation of methods was used by assigning the students to a think aloud task followed by two methods used to measure memory and comprehension, that is, retelling and multiple-choice questions. In the retelling phases, they were asked to tell everything they remembered about the passage. These retellings were scored for presence of thesis statements and the number of main ideas and details, using the checklists developed by proficient readers. After reading and retelling each passage, readers were asked to answer twenty multiple-choice questions. The results obtained from each measure were consequently not directly comparable. The retellings were used to investigate that relationship between strategy use and the information remembered, while answers to the multiple-choice questions were compared with responses to the passages to determine the amount of information apparently understood by the readers. As for the coding system, tentative categories were developed during the two pilot studies and refined during the study. These categories describe the responses of the participants and are not intended to exhaust the domain of possible strategies.

The strategies inferred were classified into two levels: general comprehension and local linguistic strategies. General strategies include comprehension-gathering (such as recognition of text structure and integrating information) and comprehension-monitoring strategies (such as correction behaviour and reacting to the text). The linguistic strategies dealt with attempts to understand specific linguistic units such as rereading and paraphrasing. In addition, two distinct patterns of strategy use were identified viz. integrators and non-integrators. The integrators were characterized by awareness of text structure, consistent monitoring of understanding. The non-integrators, on the other hand, were identified as mostly relying on their personal experiences to help them develop a version of the text, and focusing on details. Block also observed that language background (that is, Chinese and Spanish) did not account for the different patterns, that is, the Chinese did not employ strategies different from the native speakers of Spanish and even native speakers of English suggesting that language features do not determine strategy use.

Padron et al. (1986) examined to see if there are differences in the cognitive strategies that bilingual and monolingual students use while reading. Thirty eight third and fifth grade bilingual and monolingual students from an inner-city public school located in Houston, Texas of whom twenty three were bilingual in English and Spanish and fifteen were English mono-lingual were interviewed individually for 30 minutes to determine what strategies they used while reading



texts. To avoid interference of language proficiency with the ability to report orally, bilinguals were asked to report in their mother-tongue language, Spanish. The interviews were audio-taped and later transcribed and analyzed. The San Diego Quick Assessment, a graded word list, was used to determine each student's independent reading level (included in *Ekwall Reading Inventory Manual*, 1979, in Padron et al., op.cit.). The children then read an appropriate passage from the *Ekwall Reading Inventory*, each approximately 120 words long. Following the procedures used in other reading studies with monolinguals (e.g. Chou Hare and Smith, 1982, in Padron et al., op.cit.), each student read the passages, stopping at regular intervals to describe the strategies they were using to comprehend text. The strategies were then categorized by type and frequency.

A structured interview form adapted from Chou Hare and Smith was used to place the strategies into the following categories: rereading, selective reading, imaging, changing speed, assimilating to personal experiences, concentrating, assimilating to passage events, noting/searching for salient details, summarizing, predicting outcomes, self-generated questions, student's perceptions of teacher's expectations, rehearsal, and other.

While monolinguals more often reported strategies such as concentrating (or thinking about the story, remembering it), bilinguals' most utilized strategy was their perceptions of the teacher's expectations (that is, reading to answer questions that the teacher might ask). Nevertheless, this strategy was not utilized

by the monolingual students. Other strategies used by monolingual students were noting, searching for salient details, and self-generated questions. Padron et al. observed that monolinguals used almost twice as many cognitive strategies as bilinguals.

Padron et al. discuss a possible explanation for lower reading achievement of the bilingual and argue that the bilingual students were possibly transferred too quickly to English reading and were not able to develop reading strategies in Spanish reading. 'Having to read in English, bilingual students become primarily concerned with decoding and thus do not develop the cognitive strategies necessary for understanding text' (P:432).

Sarig (1987) in an introspective study investigated how reading processes of L1 and L2 are related to each other. 10 Jewish high school non-native speakers of English were asked to report their thought processes of how they construct the main idea of an EST text and to express their strategies of synthesizing the overall message of the task presented to them. Four general types of reading strategies were identified, namely, a) technical-aid moves including strategies such as skimming, scanning, b) clarification and simplification moves covering such strategies as utterance substitution, decoding meaning of words, c) coherence-detecting moves including identification of macroframe of the text strategy and d) monitoring moves comprising conscious change of planning and

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carrying out the tasks, etc. For each type of 'macro strategy', conditions were set in which strategies were classified and interpreted as either comprehension promoting or comprehension deterring. The contribution of strategy types to success/failure in reading tasks in both Hebrew and English was shown to be almost identical. Furthermore, a considerable relation was found between task performance processes in both languages, thus providing evidence for the crosslingual transfer of reading strategies from L1 to L2 (see also Koda, 1987).

Alderson (1990) in an introspection study attempted to see what processes are being followed by two foreign language Spanish informants while answering categories of a reading test. 10 items primarily designed to test higher order and lower order skills of reading comprehension were given to the testees. The subjects were individually interviewed and asked to report their strategies when answering the reading items. Performance on the items revealed that the subjects approached the items in different forms and employed different processes. Several causes have been traced for this variation of performance, namely, subjects' unfamiliarity with particular lexical items, using various skills to respond to an item rather than one main skill, failure to answer an item correctly while using the skill supposedly required by that item, and conversely responding correctly to items without displaying the skill(s) in question particularly with those items which require test-taking skills such as matching.



More recently, in a study aimed at recognizing strategy use by good and poor readers reading expository text of three different levels, Kletzien (1991) examined forty eight school students half of whom were good readers and half poor readers.

Based on the Fry readability scale, the passages were classified as independent (or 7th grade), instructional (or 11th grade), and frustration (or 14th grade) levels for the good readers. The same texts were simplified by changing some of the sentence structure and vocabulary. The passages were changed into cloze texts each with twelve deleted content words. The subjects were then asked to fill in the blanks. To get access to reading strategies after completing each passage, the subjects were asked to go back and explain their thinking process as they chose their answers. Transcribing the protocols and including comprehension strategies reported in the past strategy research, Kletzien presents a classification scheme comprising strategies such as using syntax, using the author's style, using known phrases, rereading previous text, to name a few.

The results showed that both groups used some similar strategies which included focusing on vocabulary, rereading previous text, making inferences, and using prior knowledge. The strategy use by both groups at different levels of text difficulty revealed interesting results. That is, the strategies of the two groups were indistinguishable at the independent level, while at the instructional level, good comprehenders showed a better ability to change types of strategies. They also appeared more aware of organization structure of the text than did the poor

readers. At the even more difficult level (or the frustration level), good comprehenders continued to use different strategies from the poor readers.

In addition, strategies used at the independent level shows the greatest total number of strategies. It was also found that some strategies were used more frequently than others such as use of prior knowledge. At the instructional level, subjects used a greater number of strategies which included focusing on vocabulary, making inferences as well as recognizing passage and sentence structure. On the other hand, prior knowledge strategy was used less frequently on the instructional level. As for the frustration level, subjects used different patterns of strategies including using vocabulary, making inferences, rereading previous text, and using prior knowledge. The number of organizational strategies was fewer than it was for the instructional level. On the whole, subjects showed that they were sensitive to task demands partially adapting their strategy use to the difficulty level of the text.

#### **2.1.6. Summary**

The short overview of the three most important areas of comprehension problems for the EST reading comprehenders showed the following. The role of background knowledge in EST text processing was examined by reporting various studies which determined the facilitative role of background knowledge in tackling EST reading comprehension tasks. However, other studies such as the one

the one conducted recently by Bernhardt reveals that such a role is not as facilitative as it was documented. It was also discussed that inappropriate use of background knowledge may even impede comprehension. Other studies such as Shoham et al. show that better proficient readers gain more in using subject-specific texts than less proficient readers. However, as Ulijn (1984) and Lipson discuss, the facilitative role of background knowledge is not held constant unless there is a good fit between background knowledge and text information. Concomitantly, syntactic knowledge was shown to be an important factor in second language readers' ability to process reading comprehension problems. Furthermore, studies investigating the role of vocabulary revealed that words denoting conceptual meaning, content words and semi-technical items of vocabulary appear to be more problematic to EST text comprehenders. Nonetheless, with regard to the introspective reading research mentioned above, it appears to be difficult to draw any strict conclusion about the findings. The reason can be attributed to the small number of such studies in both ESL and EST reading research. The need to conduct more introspective research in these fields is the justification for section three of this chapter where I will be arguing for more qualitative research in reading English as a second/foreign language.



# COMPARISON OF GOOD AND POOR READERS' STRATEGIES

## 2.2.1. Introduction

The significance of comprehension strategies of language learners in understanding how readers understand a text, what strategies they attend to, what they do when they do/not conceive a task, how they make sense of a text and many other relevant questions have been recognized in the literature (Olshavsky, *op.cit.*; Rubin, 1975; Hosenfeld, 1977; Block, *op.cit.*). Bialystok (1984), for example, proposes that the quest for a set of strategies that underlie the learning and use of second language has psychological and linguistic and pedagogical benefits. From a psychological perspective, the description of such strategies may help access to the mental processes important for acquisition. Linguistically, information about strategies used by the learner tell the linguist about the learner's hypothesis, whether such strategies are universal, etc. Finally, the instruction of effective strategies used by successful learners to the less successful learner is the main intention of language teachers. In this section, I will firstly give a short account of how language tests differentiate between skilled and less-skilled reading. Secondly, the differentiation is viewed from the perspective of current research on second/foreign language reading comprehension.

### **2.2.2. Defining Skilled And Less-Skilled Language Comprehenders, What Do Language Tests Tell Us?**

To differentiate the skilled from the less-skilled language comprehenders either in a first or in a second language, one requires to have defined them in advance. Within the context of a second language, basically the best tool for distinguishing the two groups from each other is through language tests designed in different forms and for different purposes (for a typology of tests designed to define first language good and poor readers see the seminal article by Golinkoff, 1975-1976). Nevertheless, studies dealing with such categorization in second language reading tests seem to have not provided researchers with a well-defined lists of skills to clearly differentiate the two types of readers. The problem of determining, developing and defining absolute scales of measurement and the number of levels for any given test, as Bachman (1990) puts it, is an empirical one and has been the concern of language testing specialists for long. Nitko (1984 in Bachman, 1990) argues the need for more clarification concerning the competence levels in the existing criterion-referenced tests:

'Research related to such test development [referencing test scores to a domain that can be ordered as levels of proficiency ...along novice-expert continuum] will need to focus initially on describing the nature of competence in a specific kind of performance or knowledge area and the relation of competent performance to cognitive process. Such research will undoubtedly reveal that there is not an underlying unidimensional continuum, and thus existing mathematical models will be difficult, if not impossible, to apply to this psychometric problem.

Defining and measuring competence seems to be an important societal concern, however, even though a scientific understanding of the psychological processes differentiating levels of competence is still largely lacking...' (P: 23).

This being said, many factors contribute to constructing the definition of novice-expert language users. Alderson and Urquhart (1985) show how prior background knowledge of a group of EST students affects their performance on a test of English for specific purposes (ESP), hence proposing that a distinction needs to be made between language proficiency and background knowledge. Farhady (1982) shows how performance on several measures of language ability is related to sex, university status, and nationality. Obviously, as Bachman maintains, any definition of language ability within the novice-expert continuum requires one to consider these constructs which may lead to redefining the present construct of language proficiency (Farhady, 1982).

Thus, defining and distinguishing skilled from less-skilled language users in tests of English for second or foreign languages is at present controversial and requires more exploration into the nature of language proficiency, human cognitive processes and other determining factors such as test methods, personal attributes (for example, see Bachman's model for explaining performance on language tests).



However, researchers have not waited for theoreticians to come up with an all-embracing definition of language proficiency and have developed tests of foreign language ability to meet academic needs of universities. Of the two well-known tests of English for speakers of other languages developed so far (i.e. TOEFL<sup>1</sup> and IELTS) only the latter defines students' overall proficiency on a band score of nine levels. A description of subjects receiving 7 on the test, for example, says:

'Good User. Has operational command of the language, though with occasional inaccuracies, inappropriacies and misunderstandings in some situations. Generally handles complex language well and understands detailed reasoning.'

As is indicated, the description is quite general and gives only a relatively rough estimation of the testees' language proficiency. With TOEFL test one is only dealing with the level of acceptability required by different universities. Even this level of acceptability, on occasions, fluctuates as performance on the test changes.

Other tests such as Test in English for Educational Purposes (TEEP) and UCLES/RSA Certificate in Communicative Skills in English propose levels of competence (that is, intermediate, advanced) but once again do not provide the reader with a detailed description of skills utilized by the testee. Furthermore, the lack of consensus in reaching a well-defined description of skilled and less-skilled readers in language testing research may be drawn to the fact that most of

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<sup>1</sup> See chapter four for a brief history of the TOEFL test and reasons for selecting this test as the dependent variable of this study.

the present language tests of foreign language proficiency assess only the product of language under assessment and not the process (Alderson, 1981; Bachman, op.cit.). It is argued that enabling skills may vary from individual to individual, and some of them may not be used by one person on one occasion to reach a given product in the performance of a particular task (Alderson, 1981).

### **2.2.3. Skilled Less-Skilled Continuum In View Of Current Foreign Language Reading Research**

Ideally, any description of a successful second/foreign language comprehender must approximate the characteristics by which a successful first language comprehender is recognized. This is true inasmuch as the goal of any L2 reading instruction should be to transcend L2 population competence. Therefore, if employing 'reading for broad phrases' strategy, for instance, is confirmed as evidence of successful reading by a native language user, the same is to be logically expected from a non-native reader. If this is the case, then any characteristics of a skilled and novice *first* language reader can equally be attributable to a skilled and novice *second* language reader respectively, hence freeing the researcher from exploring unknown domains in second language reading comprehension and in general studies of second language acquisition.

Nonetheless, constraints are present suggesting that the idea of 'native speakerness', as utilised by Allen Davies (1991), is unique to those 'born to two

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<sup>1</sup> See chapter four for a brief history of the TOEFL test and reasons



native speaking parents both preferably monolingual and raised by them to adulthood in a native speaking community' (P:3). Davies makes a clear distinction between minority ethnic communities in the UK and elsewhere and an English native speaker on cultural grounds and early acquisition of the first language. The argument is that a native speaker acquires the language of childhood:

'the language of spoken to and by children, the games, stories, songs and so on which means both childhood and language-in-childhood for children and adults. In such cases it is difficult for the English second language child to recapture except second-hand (through books and so on) an experience they did not themselves have precisely because they experienced it in another language' (P: 3).

While Davies admits that L2 learners may reach native speakerness on agreed levels of adequate performance (linguistic competence), he casts doubts on whether such an ability is obtainable at communicative competence level. Furthermore, as Block (op.cit.) argues, there are factors influencing reading ability which increase geometrically when we consider reading in a second language. Concerns such as the influence of the reader's first language and first language literacy and also the influence of second language proficiency all add to the complexity of reading studies in a second language.

McLaughlin's study (1987b) revealed that dominant bilinguals (those dominant in their native language) were noted to read more slowly in their second



language than in their first language. Furthermore, even after years of exposure to a second language, it was found that the processing speed of bilinguals fails to match the processing speed obtained in their native language.

Therefore, these indications suggest that differences exist between native language readers and individuals who are overtly balanced bilinguals in terms of text processing and strategy utilization. One simple conclusion which can be drawn is that although some of the characteristics of a successful English native language reader may be shared by a skilled non-native reader, there are concerns that some may not (e.g. translation from English as a target language to mother tongue), thus giving justification for independent research on differences between skilled and less-skilled non-native readers. Research on reading in a second/foreign language has been informative concerning characterizing differences which distinguish good from poor comprehenders. Viewing reading as an interactive process, Eskey (1987a) suggests that a successful EFL reader continues to make use of cues at all levels, from graphophonic to schematic. He contends: 'good reading is not a print-free guessing game' (P:86).

Cziko (1978) in his study of beginning, intermediate and advanced L2 learners found that while all readers were able to use syntactic clues (those provided by the rules of the language), only the advanced L2 readers and the native speakers

were able to use semantic clues (those provided by the meaning) and discourse clues (those provided by the text topic).

In Mac Lean and d'Anglejan's (1986) study, advanced EFL readers had difficulty using within-sentence information on the L2 text. The results appear to contradict Cziko who found that advanced L2 learners were able to use semantic and discourse level clues as effectively as native speakers.

Douglas (1981 in Mac Lean and d'Anglejan) in his study of Japanese ESL students, found that native and non-native speakers differed in their ability to use extra-clausal information. He suggested that 'the second language readers would seem to be focusing too closely on the sequential print data and not making enough use of information which is available from many sources throughout the passage' (P:101).

In a study of reading strategy differences among skilled and novice EFL comprehenders, Hosenfeld observed that her skilled reader kept the meaning of the passage in mind as he read and read in broad phrases while the novice reader lost the meaning of the sentences as soon as he decoded them and read in short phrases. The skilled reader skipped words that seemed to be unimportant to total phrase meaning and used the remaining words in the sentence as clues to an unknown word and context of the preceding passage to decode it whereas the

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novice reader seldom skipped unimportant words and gave an equal weight to all the words in the text.

McLaughlin (1987a) found that more proficient bilinguals appear to utilize different lexical processing strategies than less proficient bilinguals. The more proficient bilinguals made lexical recognition errors suggesting that they utilized 'semantic encoding' whereas less proficient bilinguals did the same but using 'acoustic (phonemic) encoding'. It is thus concluded that the less proficient bilinguals needed to devote greater attention to meaningful portions of the text.

In another study, McLaughlin (1987b) examined differences in syntactic processing between proficient and less proficient readers of a second language.

The question addressed in this study was the way in which individuals process continuous text while reading in terms of attention to meaning as distinct from structure and form in the text. Subjects were given a letter-deletion task in which individuals crossed out certain letters in the text. The less proficient readers crossed out the letter in both content (meaning) and function (articles) words with nearly equal frequency, the more proficient readers deleted the letter in content words. It is then suggested that more proficient readers pay attention to meaning-based aspects of the text whereas the less proficient readers focus attention to those aspects of the text that may not have been crucial to extract meaning. It also suggests, as asserted by McLaughlin, that the more proficient



readers had reached a degree of automaticity in reading and that they facilitated the processing task to pay more attention to meaningful parts of the text.

#### **2.2.4. Summary**

This section sought to propose different issues about the comparison between good and poor language readers mainly in English as a second/foreign language. Second language reading comprehension was thought to be more difficult and complex due to a host of various factors which are involved in L2 reading comprehension. The inadequacy of definitions given by second/foreign language tests regarding a definition of skilled vs. less-skilled reading comprehenders was also referred to. A survey of L2 reading comprehension research mentioned above reveals the following conclusions: a) a bilingual skilled reader can obtain the linguistic competence of an English native speaker, however, s/he may not become as communicatively competent as an English native speaker (Davies, op.cit.); b) the processing speed of skilled bilinguals is quicker in their first language than it is in their second language (Mc Laughlin, 1987a); c) skilled readers activated their background knowledge more effectively than the novice readers (Trimble and Trimble, op.cit.); d) skilled readers made greater inferencing from context to get lexical meaning than the less-skilled readers (Cooper, op.cit.).

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## METHODOLOGICAL UNDERPINNINGS OF THE STUDY

### 2.3.1. Introduction

The dichotomy between qualitative and quantitative research can often be found in the literature and has been subject to debates among research methodologists (Grotjahn, 1987; Seliger and Shohamy, 1989). For example, some like Grotjahn avoid using the dichotomy on the basis that the terms are not explicitly defined. The term 'qualitative' is used in different senses. For instance, it is used in terms of the level of measurement of the data (that is, considering data measured on an interval scale as quantitative while classifying data measured on a nominal scale as qualitative). Others such as Filstead (1979) have used the term in a wider sense so that it may refer to an entire paradigm from the manner of data collection and theory construction to the manner of data analysis. While the use of quantitative research or 'analytical-nomological methodology', to employ Grotjahn's phrase, in second language studies is accepted as a scientific methodology on the basis of certain recognized criteria (that is, objectivity, reliability, validity), as yet no preferred research approach, as Seliger and Shohamy discuss, for the study of all second language phenomena is advocated by the researchers. This, in fact, is due to the complexity of second language research itself and the variety of ways in which it may be studied.

In the following sections, I will account for three major points comprising mainly: the need to select a qualitative approach in this study, the reason to choose thinking-aloud technique as a research tool in this undertaking, and a discussion of the main strengths and weaknesses of the chosen approach.

### **2.3.2. Justification For Selecting Qualitative Methodology**

My first reason for selecting qualitative research methodology was related to the lack of any concepts in the literature to elaborate on my novice subjects' reading comprehension failures in tackling their academic texts and comparing them with those of skilled readers. The bareness of the area required me to view the problem from the data perspective (Ericson and Simon, 1993) rather than to apply pre-conceived theories or hypotheses in advance to the area. Employing an 'analytic-nomological' approach to my area of investigation for which almost no data had been gathered and analyzing its variables into its components was thought to result in a distortion of the phenomenon. Using a holistic approach, on the other hand, given the above area of research might be more appropriate and give a valid picture of the phenomenon under the study.

My second justification emerges from the recent growing interest in qualitative research and the need of researchers to tackle process and not the product in many areas of second language studies such as interlanguage (Farch and Kasper,



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1983), discourse analysis (Seliger and Shohamy, op.cit.), reading comprehension (Just and Carpenter, 1984) and language testing (Alderson, 1990). Many recent illuminating observations about second language phenomena are in one way or another in debt to research methods which have examined second language processes in different areas of investigation. This tendency has resulted in the development of sophisticated methods for data collection and analysis which have provided results that would not be possible through analytic-nomological designs. My third reason in adopting a qualitative approach can be attributed to the research interest factor (cf., Cavalcanti, 1983). As a researcher, I have been willing to investigate qualitatively what processes and strategies are being aspired to by inadequate second language readers in the hope to diagnose the weak aspects by comparing them with those of skilled processes and strategies. Having scrutinized other techniques employed in process-oriented research, I have found the thinking aloud method to be the most effective means of achieving my aims.

### **2.3.3. Methods For Tapping The Reading Process: Justification For Adopting Think-Aloud Protocol Methodology**

Since the development of reading models such as Goodman (1967), various methods have been employed to tap reading processes. This is, to a considerable extent, exemplified in reading case studies which have thus far utilized various methods from on-line processing measures or eye fixations (Carpenter and Just, 1986; Rayner and Pollatsek, 1989) to miscue analysis (Miramontes, 1987)

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introspective techniques (Hosenfeld, 1977; Block, 1986; Cotterall, 1990) and recall protocol methodology (Bransford et al., 1984; Steffenson and Joag-Dev, 1984; Bernhardt, 1991). An important feature of case studies is their dedication to exploring and tackling subjects' views, mostly inferred, on such matters as their interests, needs, strategies and notions when interacting with a text. Such studies provide the researcher with an opportunity to better understand cognitive processes underlying reading behaviour. Undoubtedly, this has been a major force behind the recent illuminating investigations on reading processes through case studies.

However, some of these methods are reported to have some weaknesses in tackling reading processes. In this section in order to justify my selection of one of these tools, mainly introspection, I resort to a set of criteria proposed by Cavalcanti (1987) who observes reading as:

1. a silent (on most occasions) and private activity which gives performance data;
2. part of a genuine situation in which electronic devices are used minimally;
3. a process which allows the reader to understand the ongoing thoughts;
4. based on an authentic text laid on its full context and not in chunks; and
5. done in foreign language.

### 2.3.3.1. Eye Movement Method

The on-line reading measure or eye movement research (Huey, 1908 in Baker and Brown, op.cit.) which measures reading behaviour is perhaps one of the oldest methods used to describe subjects' reading processes and strategies. Huey and his contemporaries were interested in eye movements in reading, the nature of the perceptual span (how much information can be perceived during a fixation of the eye), word-recognition processes, inner speech, reading comprehension, and reading rate. The theory behind the technique is that during reading a reader's eyes do not move smoothly along the lines of print. Rather our eyes make a series of jumps (or Saccades in French) along the line. As Rayner and Pollatsek explain, the eyes rest for periods that are usually between 150 and 500 milliseconds. These periods are called fixations. Saccades or the rapid movements of the eye occur between the fixation periods. The experiments recently done by Rayner and Pollatsek reveal that our eyes generally move forward about 7 to 9 character spaces with each saccade. As for the duration of saccades in reading, the experiments show that it takes about 20 to 35 milliseconds. However, the important point in eye movement research is that while the saccades present little visual information to the researcher, all visual information, according to Rayner and Pollatsek comes during fixations.

The main concerns of eye movement research are the following: a) to understand the process of normal silent reading (which undoubtedly accounts for

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well over 90% of the reading adults do), according to Rayner and Pollatsek, and to get access to strategies by systematically studying the reader's allocation of processing time across the text (Carpenter and Just, 1986); b) to deal with many aspects of reading behaviour including word identification, the effect of context on lexical access, syntax, semantics (Rayner and Duffy, 1986 cited in Rayner and Pollatsek), to name a few.

In addition, recent advances in interactive computer programs permit readers to control the amount of time on a text and to reread whatever part of the text at will (Mitchell and Green, 1978 cited in Baker and Brown, *op.cit.*).

No doubt eye movement analyses have had considerable effect on our understanding of the reading monitoring and strategies. However, the use of eye movement technique requires use of sophisticated equipment which more often seem to be unobtainable for an average researcher. This is quite evident at least within the domain of ESL reading, where few, if any, second language reading researchers have utilized this technique to unravel reading processes and strategies. In addition, since information obtained from eye movement research comes from the reader's fixation, it has been argued that such fixations cannot reflect what processes are being executed. In actuality, as the reader reads a text, many intervening processes such as memory overload resulting from previous

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processes of the text are not veiled. Therefore, to be fruitful, eye movement research should be supplemented with performance measures (see the first criterion above), as suggested by Baker and Brown (1984).

### **2.3.3.2. Miscue Analysis**

Originating from the past, oral reading or reading aloud has been one of the tools for recognizing reading problems of beginning readers both in first and second language (Davies, F., 1995). The modern version of oral reading called miscue analysis comes from the theory of reading as a 'psycholinguistic guessing game' proposed originally by Goodman (1969) in the early 1970's. Since then, miscue analysis methodology has been conducted in reading research in the hope to account for reading processes and strategies. The assumption is that errors in oral reading of students can provide the teacher-researcher with information about reading strategies and process. In this method the reader is required to read a text orally and based on the errors the reader makes inferences are drawn as to the reading processes. The errors can then be classified and analyzed. In more sophisticated variations, words may be misspelled or anomalous in the passage and subject's responses (pauses and hesitations) to such words are examined, as are the characteristics of the word the subject actually utters. An example of such a classification appears in Davies as the following:

-omission of a word/phrase,

- rereading/repeating,
- segmentation of words,
- substitution of words.

However, despite the merits of the method, two main problems are posed against the miscue analysis method. First, as Rayner and Pollatsek contend, 'it is unnatural for adults' (P:180). Adults rarely read aloud and when they do they do it most of the time for the sake of 'presenting', say poetry or reading aloud a story for children. Second, in analyzing the pattern of errors one cannot be sure that the errors are 'errors of identification or errors of interpretation or memory' (Rayner and Pollatsek, P:181). They contend, '[f]or example, when reading aloud, readers often give synonyms or paraphrase. However, it is by no means clear that they really encoded the text that way' (P:181).

Another serious problem in using the oral reading relates to the fact that most oral reading errors are the result of processes occurring after the lexicon has been accessed. Rayner and Pollatsek report the work on the *eye voice span* (Levin, 1979). The technique relates eye movements records to a record of the vocal output. It is measured that on the average the eye is ahead of the voice by a couple of words. If this is the case, then it is entirely possible that the words produced in oral reading are influenced by processes occurring after the lexicon has been accessed, 'thus the resulting data may say little about how the lexicon



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is initially contracted to arrive at the meaning of a given word' (Rayner and Pollatsek, P:181). They continue the criticism by stating:

'Oral reading errors have served as the basis for a view of reading in which it is believed that fluent reading is based on generating *guesses* or *hypotheses* about what the next word is (Goodman, 1970; Levin and Kaplan, 1970). Because the errors produced in oral reading tend to be semantically consistent with the words actually printed in the text, some workers have assumed that oral reading errors provide good evidence for this view. In reality, most oral reading errors are the result of processes occurring after the lexicon has been accessed' (P:181)<sup>1</sup>.

In addition, since it does not meet the requirements mentioned above it was dismissed as a suitable reading process/strategy investigation method.

### **2.3.3.3. Recall Protocols**

Basically, recall protocol analysis relies on the 'written summaries' of the reader after a text is read. These protocols are later analysed and inference to the reading process and strategies is made. A recent work in ESL reading comprehension which relies heavily on results obtained from recall protocol analysis is Bernhardt mentioned in chapter 2. Although the results of the study nicely fit in an interactive model of reading, the study falls short of accounting on certain aspects of analysis. For example, Bernhardt does not show using idea units (or propositions being defined in terms of size and semantic load) matched with the recall protocols. The study also does not discuss the recency effect of recall protocols. The recency effect refers to time lapse between the

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actual reading of the text and its recall which causes the readers to rely more on the gist of what was read rather than on the details. In addition, the problem presents itself when the recall analyst assumes these summaries as 'texts in their own right', that is to say, 'their analysis of recall protocols accounts for the text base and for the recall protocols proper' (Cavalcanti, 1987; P:232). Due to the time interval between the reading of the text and its recall, it can also be argued that such process-inferencing methodology does not capture the reader's *ongoing thought* and therefore was dismissed as a proper reading process tool to be used in this study.

#### **2.3.3.4. Reading Recorders**

Tapping reading comprehension processes and strategies through reading recorders is a fairly new trend. It was Thomas and Harri-Augstein (1972) who designed a reading recorder called the 'Brunel Reading Recorder' which allows a reader to see an average of five lines at a time through a viewer. The recorder produces print-outs showing the reader's pauses, think sessions and the time spent on each pause. These print-outs which reveal patterns of reading are then talked back with the reader in a sort of retrospective manner asking the reader to comment, for example, on why s/he paused and spent much time on some

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<sup>1</sup> The reader is directed to read Dulay, Burt and Krashen's *Language Two* (1982) for the problems in the descriptive aspects of error taxonomies as well as definitions of errors categories.

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particular parts of the text (see also Harri-Augstein and Thomas's ,1984 article on conversational investigations of reading).

One important advantage of conversational investigation technique by the aid of reading recorders over the eye movement methodology is that although both methods rely on the external observation of reading comprehension, the former is substantiated by introspection into reading process (Alderson and Urquhart, 1984). However, looking at the technique from the perspectives laid out above, this method violates criteria 2 and 4. The main disadvantage of this method resides in its chunking the text which makes it unreal and tiresome (Cavalcanti, op.cit.). It is also noticeable that the use of such recorders seem to be uneconomical in terms of the budget it may impose on a researcher.

#### **2.3.3.5. Introspection**

Having observed all previous methods of tackling reading process and strategies, it was found that the thinking aloud technique meets the set of criteria proposed earlier and, therefore, is more advantageous in terms of the information it provides. In the next section, I will account for the main strengths and weaknesses of introspection as a means of tackling reading processes.



As all research measures have their potential strengths and weaknesses, think-aloud method displays some strengths and suffers from some weaknesses. The main *strengths* of the approach is as follows:

- the approach reflects more accurately what learners actually do than might a response to a questionnaire or an interview item which calls for a description of behaviour, that is, questionnaire or interview items are more likely to elicit learners' belief about what they do rather than what they actually do;
- the approach reveals information about ongoing thought while people perform a task - information that is otherwise lost or inaccessible to the investigator.

The main *weaknesses* of the think-aloud approach are as follows:

- unconscious automatic processes are not accessible to verbalization;
- the results may vary depending on the characteristics of the informants such as their verbal skills, that is, some respondents may be more adept than others in providing the appropriate amount of verbal report data;
- due to the nature of introspection methodology which is in most cases tied in with studies of individual performance rather than a large population of subjects, it does not meet the external validity criterion (that is, generalizability) unless it is accompanied with other methods of data collection such as recall methodology or eye movement technique;

- instances of text-task interaction (or task effects) could be expected particularly when level 3 verbalization is required from subjects (see also next chapter section 3.1.2.2.).

### **2.3.4. Pilot Study**

Having selected introspection as a method of investigating reading problems of the subjects under the study and also due to lack of any investigation about reading strategies and processes of the student population of this study, I decided to begin with a purely qualitative approach to get insights into the reading strategies of a sample of the population by adopting a pilot study. Therefore, no hypotheses or preconceptions about reading strategies of the subjects who took part in this phase were initially made. Therefore, this initial part of research was absolutely qualitative. Arrangements for nine separate interview sessions were, thus, made with a group of post-graduates who had just started their Master's course in Microbiology at Tarbiat Modarres University of Tehran, Iran, and who wished to have an academic view of their language problems. To make sure about their language proficiency, they were given a sample reading TOEFL test prior to the experiment (see also justification for selecting TOEFL in the next chapter).

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The reading materials given to them were similar to those which were later on administered to the real novice population of the study. Readability of the texts had previously been checked as being suitable by the researcher and two of the EFL university lecturers. Necessary steps were taken to make the experimental task as real as possible. The sessions were tape recorded and after analysis of the protocols the students were informed of their flaws in reading academic texts.

The data obtained did contribute significantly to providing the researcher with two main things: information about how an experiment of this sort should be administered highlighting particularly the weak points of the experiment; information about reading strategies. For example, regarding the former it was found that inserting dots as a reminder for reporting thoughts at the end of each sentence (cf. Olshavsky, 1976-77) caused interference with reading comprehension and interestingly enough lack of them made some students forget about reporting their thought processes during reading comprehension thus providing justification for occasional probings. On the theoretical side, it was observed that they approached the text in a problem solving manner (or identifying problems and employing comprehension strategies to overcome them). The reading strategies reported were mostly ineffective. Also, the reading strategies displayed a relationship between them and the scores the



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subjects obtained in their TOEFL tests. These preliminary findings led to the formation of research questions and the main hypotheses of this study.

### **2.3.5. Research Question**

The pilot study served to illuminate, though crudely, areas of the problem identified. This identification helped me to conceptualize research questions and form somewhat weak hypotheses about the target population. Looking at all of the different strategies and trying to categorize them into the patterns which seem to emerge from what has been observed may result in further hypotheses about the target population.

Therefore, the main aim of this research is heuristic in order to identify, classify, and describe as many strategies as possible which might be related to weak and strong reading comprehension among the target populations.

- The first main research question addressed in this study deals with comparing strategy use of a group of novice second language EST readers studying academic English in Iran with another group of skilled second language EST readers from the same ethnic population but studying at the highest academic levels outside of their mother land, viz. in an English native speaking country here in Scotland. This in itself requires two more sub-research questions mainly:

-- to identify what set or sets of strategies used by the novice readers,

- to identify what set or sets of strategies used by the skilled readers.
- The study also examines whether the readers follow an interactive approach to reading comprehension.
- The third research question involves an examination of the degree to which the readers' performance of this study reflects the individual difference factor in reading comprehension.
- Finally, the last research question deals with examining the relationship between number of reading strategies and proficiency gains of the reader informants of the study.

### **2.3.6. Research Hypotheses**

The readers are expected to follow an interactive approach to solving problems in comprehension. The second hypothesis posits that there are common areas in the readers' use of comprehension strategies which make the individual differences hypothesis in reading comprehension a moot issue. A third hypothesis is that there is a positive relationship between the number of strategies used by informants of each group and their performance on the TOEFL test.

### **2.3.7. Summary**

This section discussed the researchers' justification for selecting a qualitative methodology. It was posited that qualitative methodology would give better picture of the reading problems in the context of this study due to lack of any previous research, and the recent general tendency in exploring reading processes through the application of qualitative methods. It then compared different reading process methods used in order to justify the researcher's selection of one type of reading process method, that is, think-aloud methodology. By employing think-aloud method in a pilot study with the purpose of identifying, classifying and describing reading strategies between the skilled and novice reader informants of this study, the main hypotheses of the study were formed.



# Chapter Three

## Introspection & Reading Theory

# THEORETICAL BASES OF VERBAL REPORT DATA

## Section I

### ***3.1.1. Introduction***

This chapter is divided into two main sections. The following sections expound the theoretical underpinnings of the present study. First, it explains the theoretical basis of the think-aloud methodology. It secondly justifies the researcher's choice of an interactive approach to reading comprehension by comparing it with other models of the comprehension process.

As the history of using reports shows, the think-aloud method was used by Newell and Simon (1972) as a method of finding thought processes in a mathematical problem solving activity. The purpose of the study was to observe through think-aloud analysis what strategies are used by the subjects to solve mathematical problems. According to Newell and Simon, the first think-aloud tapes (on a logic task) were transcribed in 1957, and the tradition in the use of verbal protocols was started as a technique to check computer models of information processing. Since then, think-aloud protocols analysis has been applied in different fields of study such as logic and cognitive psychology and recently learning strategies (e.g. O'Malley and Chamote, 1990) and text comprehension (Cavalcanti, 1987). To account for their

findings most of these studies have borrowed the problem solving model of mathematical analysis proposed by Newell and Simon and applied to reading research studies (e.g. Olshavsky, 1976-77; Cavalcanti, 1983). Few, if any, of the studies using think-aloud protocol analysis have genuinely accounted for one of the basic theoretical concepts of think-aloud methodology, that is, human information processing system. A description of the system bears attention on the grounds that:

- it sheds light on how information heeded on attention could be interpreted as process information in reading research;
- it explains what information is and/or is not available to verbalization.

#### **3.1.1.1. Human Information Processing System**

‘The most general and weakest hypothesis we require is that human cognition is information processing: that a cognitive process can be seen as a sequence of internal states successively transformed by a series of information processes’ (Ericson and Simon, 1987; P:25). Central to this perspective is the notion that human beings have limited information processing ability. According to the theory, there are several memories in which information is stored. The most important types of memories in this view are short term memory (STM) and long term memory (LTM). An important basic



assumption of the information processing system (IPS) is that only a few characteristics of the IPS seem to be invariant over human beings: the size and access characteristics of the two main memories and the goal-like character of IPS (Newell and Simon, op.cit.).

#### **3.1.1.1.1. Size And Access Characteristics Of STM And LTM**

An STM has a limited capacity and intermediate duration. The contents of STM appears to consist of a small set of symbols (or chunks<sup>1</sup>). The STM seems to be immediately and completely available to the IPS processes. However, as Newell and Simon contend, there are no studies that show convincingly how the accessing takes place. As to the intermediate duration of information kept in STM, there is good evidence that information in STM decays. However, the reason as to why decay occurs is a matter of controversy. The reason for this so far proposed according to Newell and Simon, is either that the decay is caused by interference among symbols in the memory or is a strictly time-dependent process. As the theory purports, it is assumed that STM keeps information recently heeded by the central processor. The information is therefore, directly accessible for more processing. However, due to the limited capacity of STM, only the most recently heeded

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<sup>1</sup> These chunks, according to Newell and Simon, are recognizable stimulus patterns designated by particular symbols and serve as the internal representations for the corresponding stimulus patterns or chunks. To simplify the term, we can say that the letter C, or the number 2 are all recognizable patterns.

information is accessible directly. Furthermore, a portion of the content of STM is available in LTM before the information is lost from STM and can sometimes be retrieved from LTM.

LTM, on the other hand, has a very large capacity and relatively permanent storage. Compared with STM, it has a relatively slow fixation (that is, processing time for a datum to be stored) and access times (or retrieval). The two memories are also different in terms of information retrieval and further processing (e.g. for generating verbal reports). Retrieving information from LTM is a different process, in that information from LTM must first be transferred to STM before it can be reported.

#### **3.1.1.1.2. Goal-Like Character Of IPS**

An important aspect of IPS invariant over people and over tasks is the existence of goals. As Newell and Simon observe, the external behaviour of human beings indicates its goal-directedness. The question which they pose is whether this goal-like character of human behaviour has any structural significance in the IPS. The answer is positive. The IPS has goals with certain characteristics:

'1. A goal carries a test to determine when some state of affairs has been attained, in which case the goal is satisfied' (P:807).

There are different events happening in our daily life which indicate our assessment of the goals we have planned. Reading for memorising, checking our weight after a course of fasting, and many other similar instances are examples which exemplify that our goal can be tested in a way which determines the successful completion of the goal.

'2. A goal is capable of controlling behaviour under appropriate conditions. We then say that the IPS is attempting to attain the goal' (P:807).

Goal-directed behaviour does necessarily need a controlling device to prevent mal-application of the behaviour. If the goal of a foreign student is to obtain performance fluency in speaking, then he must be equipped with a controlling device which prevents him from application of his mother tongue in situations when he mustn't use it. Regarding the IPS, Newell and Simon point out: 'If there are goals, then the program (or IPS) must contain processes for creating goals, testing them, updating them, selecting methods for attempting them, evoking them, discarding them, and so on' (P:807). The evidence for goal activity is ample in the behaviour of human beings.

#### **3.1.1.1.3. Thought Processes Within The IPS**

To account for the subject's thought processes (that is, information structures or chunks) within the IPS, the model describes them as a sequence of states of

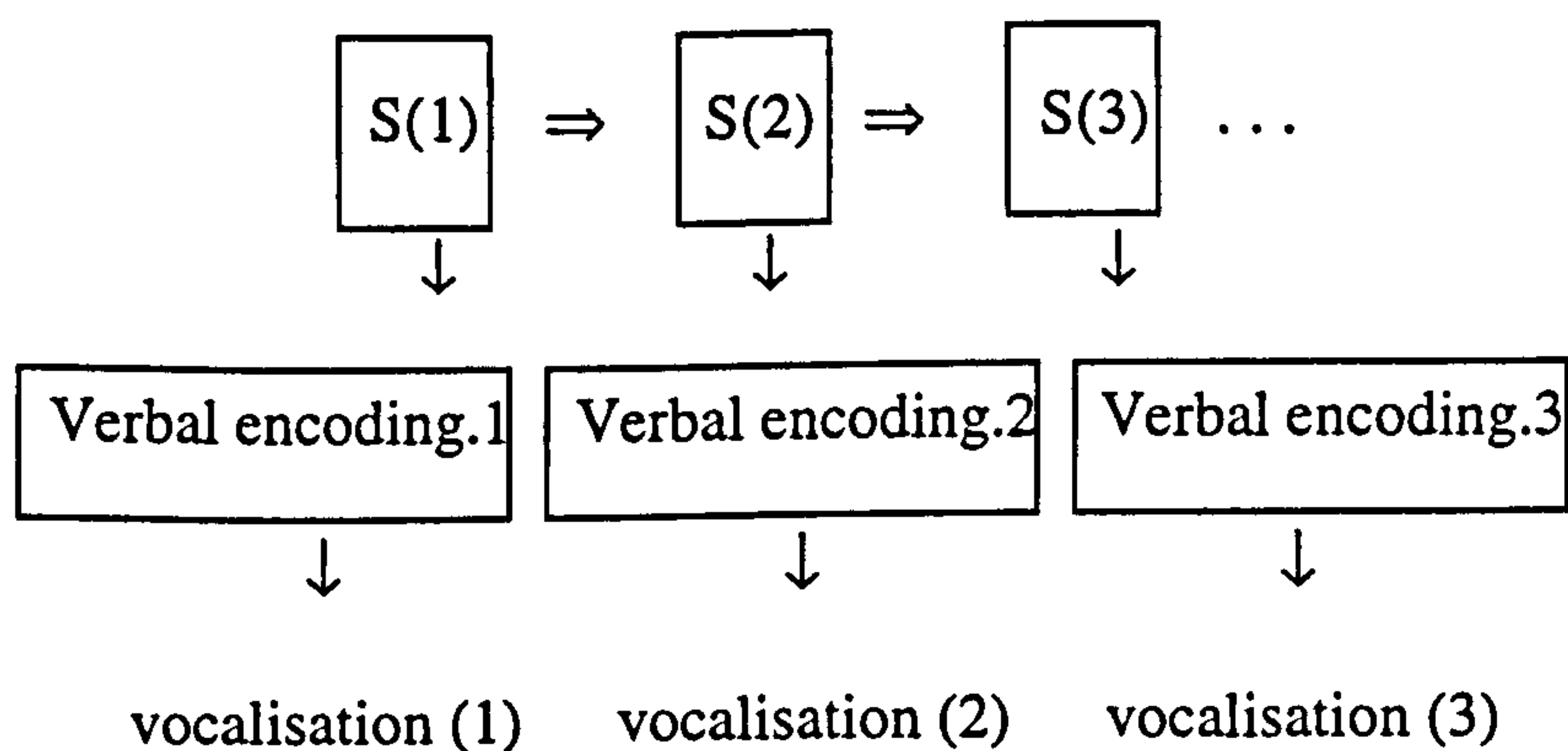


information that are available in the limited storage capacity of STM. A critical assumption, as Ericson (1988) points out, is that information must be heeded before it can be verbalised and thereby made observable. A subset of this information is kept in STM and is retrievable after the thought processes (or information structures) are completed at the end of a task.

A question which may be raised here is what information is supposed to be retrievable from STM. Within the framework of IPS there is a relationship between thought processes and the task requirements. Many of the studies in logic (e.g. a game of chess) and mathematics (e.g. multiplication of 4 digit numbers) which have thought processes involved in problem solving activity within the theoretical framework of IPS are based on the notion that there is a relationship between the structure of the task (which has been taken as input in the form of a computer model) and the corresponding answers (as output). That is, by a detailed analysis of a task, 'it is often possible to enumerate a wide range of *a priori* acceptable models that generate desired answers as a result of sequences of processing steps' (Ericson and Simon, op.cit.; P:26). Therefore, the study of thought processes within the IPS requires an analysis of the corresponding task/s which provide *a priori* expectations about the possible thought processes.

### 3.1.1.2. Theoretical Considerations Of Concurrent Verbal Reports Within The IPS

As was stated in the previous section, cognitive processes from the perspective of the IPS are a sequence of states each of which relates to thoughts (or information) in attention and STM. In order to obtain verbal reports, the subject should verbalise the thought processes (or information) which have entered his attention. The new incoming information is retained in attention until its corresponding verbalisation is complete. An important aspect of the procedure is that the sequence of states remains the same with the verbal report procedure. A schematic representation of this sequence is given by Ericson and Simon (1993) as below:



**Figure 3.1. A schematic representation of the states of information in a cognitive process and their corresponding verbalizations under concurrent think-aloud condition.**

As with other models of human cognition, verbal report procedure has been the subject of controversy in cognitive psychology. Scientists have posed

questions on the validity of verbal report data. To answer the criticism levelled against verbal report methodology, Ericson and Simon (1980; 1984; 1993) have provided cognitive psychology with theoretical and empirical findings which in turn illuminate other aspects of their verbalization model. These further aspects of the verbal report model are exemplified in the responses made to the criticisms.

### **3.1.2. Criticism Of Verbal Report Data**

While the core of verbal report investigation is expressing instantaneous reports on thoughts while they are occurring, some critics have suggested that it is unlikely to reflect a complete profile of the 'stream of consciousness' while it is happening (Sternglass and Pugh, 1988). In this regard and from a theoretical perspective, Reid (1987 quoted in Sternglass and Pugh, 1988) argues the separation of language and thought explaining that :

'...language and thought exist in separate domains: thought falls within the domain of the personal and individual, whereas the semantic categories of language are part of a public social structure. It is to be expected then that moving from one domain to the other would involve a transformation. This disengagement of thought from language also allows for the possibility that certain thoughts exist in a non-linguistic state as complex conceptual gestalts' (P:9).

While it is true that such transformation causes a gap between what Sternglass and Pugh calls 'direct experience' and language, it must be accepted that verbal report



seems to be the closest and most feasible possible way to tap one's instantaneous process of thought. Nevertheless, other ways have been proposed to compensate for this shortcoming. In this regard, it is argued that it is possible to have 'people introspect using sign systems other than language' (Sternglass and Pugh, op.cit.; P:6-7).

The main problems discussed in the recent literature are, roughly summarised, the following:

- which mental processes are accessible to verbal reports?;
- does the instruction to verbalise change the process of thinking in its very nature?;
- how complete and correct can verbal reports be? (Borsch, 1986).

### **3.1.2.1. Inaccessibility Of Mind Processes From A Theoretical Perspective**

Introspection into mental processes has been viewed by some cognitive psychologists as suspicious (Nisbet and Wilson, 1977; Miller, 1962 cited in Nisbet and Wilson). The scepticism originates from the idea that individuals do not have access to higher order mental processes (that is, thinking). For example, Miller stipulates that what appears in consciousness is the *result* of thinking and not the process of thinking. Neisser (1967) also believes that 'constructive processes' or higher order mental processes themselves never appear in consciousness in order

to be accessible to report, but their products do' (P:301). Accordingly, what we have as introspective data based on inference are not reflections of conscious mental processes.

#### **3.1.2.1.1. Mindlessness Theory: Controlled vs. Automatic Processes**

Another related question concerning specifying what mental processes are accessible to verbal reports resides in the *mindlessness theory*. A body of related research indicates that people often behave mindlessly (Langer, 1978 in Hample, 1984). The theory explains that repetitive behaviour which is recurrently overlearned may cause people to follow certain appropriate scripts without paying conscious attention to what they are doing (Schneider and Shiffrin, 1977; Schank and Abelson, 1977).

Obviously, as Hample asserts, the notion of mindless activity has serious implications for verbal report validity. As Hample discusses, one such connotation for verbal report might be the *artificial* provocation of self-consciousness in subjects who are required to introspect. And if subjects are informed before the activity about self-report enterprise, the retrospective verbal report may result in a different behaviour (Hewes and Haight, 1980 cited in Hample, op.cit.).

A rather more pertinent issue in regard to mindlessness theory is Schneider and Shiffrin's description of *controlled* search versus *automatic* detection in perception and memory. Automatic processing emerges from practice and does not necessarily require attention and runs too quickly while controlled processing requires attention and is mostly used for unfamiliar and difficult tasks. It is, therefore, argued that under controlled conditions it becomes possible to attend more to mental processes. On the other hand, automatic processes which are rapid are inaccessible and are, in Schneider and Shiffrin's term, *veiled* (P:159).

A similar distinction is made by Shank and Abelson (1977, in Smith and Miller, 1978) between *plan* and *script*. Plan is exemplified when a skill is being acquired which requires conscious attention to every aspect of the activity, hence it is defined as conscious and accessible. Script processing, on the other hand, is an index of fluency in a skill done quickly and which does not require attending to mental processes (an example would be a typist. When s/he reaches a stage of fluency in typing s/he is judged as one who has overlearned the skill and his/her skill is 'in the finger'). Smith and Miller, therefore, contend that 'as skills develop, the fluency of the action increases and conscious control lessens' (P:361).



The main point generally agreed by these writers is that accurate verbal report is not possible unless people act mindfully. However, counter arguments have indicated that people can give verbal reports based on the things they cannot remember (Jacoby and Witherspoon, 1982 in Hample; Nisbet and Wilson, op.cit.). The implication of such studies is that self-reporting may not be as strongly affected by the consciousness or memory traces as the mindlessness literature proposes. This evidently suggests that people can provide accurate verbal reports without having access to higher cognitive processes (for more information see Nisbet and Wilson's work on *subliminal perception*, 1977). Nisbet and Wilson propose situations in which correct self-reports will be distinguished from those which are not. As Smith and Miller discuss, the novelty of the tasks and the degree to which they are engaging for the subjects often seem to evoke accurate introspection awareness of process.

#### **3.1.2.1.2. Declarative vs. Procedural Knowledge**

Another pertinent issue in relation to mental processes accessible to verbal reports is the distinction which is made between two states of knowledge, that is, the declarative and procedural knowledge dichotomy. The first kind of knowledge, according to Faerch and Kasper (1987), includes linguistic knowledge at all its levels. In other words, linguistic competence or knowledge about language is referred to as declarative knowledge. This knowledge covers such knowledge as

rules for phonology/graphology, morphology, and syntax: rules for pragmatic and discourse knowledge; and rules for social interaction. Procedural knowledge, on the other hand, plays an intermediary role whose purpose is to activate declarative knowledge and to increase it through learning. Conforming with prevalent notions in cognitive theory, O'Malley and Chamote (1990) state, 'declarative knowledge tends to be static while procedural knowledge takes an active role in transforming facts and data stored as declarative information' (P:58). The implication of this distinction for the study of cognitive processes is that, according to Faerch and Kasper, most declarative knowledge is activated in a conscious manner, while procedural knowledge tends to be automatic and is activated without awareness, thus, requiring few demands on STM. The most direct consequence of such a distinction is that verbal report fails to reflect on those aspects of language processing that are executed automatically, that is, procedural knowledge which leaves little, if any, traces on the memory and is therefore, not accessible to verbal report. However, as Faerch and Kasper assert, under some circumstances such as breakdowns in communication due to failures in comprehension which require the reader to refocus attention on the task procedural knowledge becomes conscious and is noticed. Furthermore, as O'Malley and Chamote rationalise, '[t]he question concerning awareness of mental processing bears upon research methodology ..., since without awareness of otherwise automatic processes, learners would never be able to describe how they learn' (P:80). Within Ericson and Simon's (1993)

model of verbalisation, what is heeded as information in STM during verbal report is only task information and not the processes. Nevertheless, this information presents cognitive process representation.

### **3.1.2.2. Effects Of Task On Verbalisation**

A second important criticism levelled at the theoretical tenets of verbal report theory is the question whether the instruction to verbalisation changes the process of thinking in its very nature. In other words, as is asserted in the introspection literature, suspicion lurks that task characteristics may influence the processes of verbalisation inasmuch as subjects are required to do two things simultaneously, that is, performing the task that is being studied and producing the verbalisation (Ericson and Simon, 1980; Afflerbach and Johnston, 1984; Bereiter and Bird, 1985)

In this regard, Britton, Glynn and Smith (1985) propose a 'cognitive workbench' model of working memory arguing that cognitive affairs occur on this workbench which is of limited capacity. According to the model, due to its restricted size, the possibility that the system fails becomes greater if it is overcrowded with both performing process and reporting on them since too many things happen at the same time.



The core criticism is that performing the task and reporting on cognitive events requires one to use intermediate processes which in one way or another bias the result and invalidate the verbal report and hence give an inaccurate picture of the normal course of the data.

Such a criticism is, nonetheless, ruled out by Ericson and Simon (1993). Drawing on their verbal report model, Ericson and Simon suggest conditions under which verbal reports are not hampered with the intermediate processes nor are the processes delayed. The model assumes three levels of verbalisation: level 1 verbalisation which involves 'direct articulation of information stored in a language (verbal) code' (P:227); level 2 verbalisation which refers to the situation where 'the internal representation in which the information is originally encoded is not in verbal code but has to be translated into that form' (P:219); and level 3 verbalisation which requires subjects to verbalise for a selected type of information and postulates that further processes are needed to test whether the heeded information matches the desired type.

This being so, Ericson and Simon comment that when the subjects are required to articulate directly information *available* in short term memory (STM), the model predicts that thinking-aloud will not change the course and the structure of processes nor will verbalisation endanger the speed of the processes. Furthermore,

the proposition appears to be valid for situations where performance may be highly automated and thus may not need to resort much to STM (See the dichotomy between automated and controlled processing discussed by Shiffrin and Schneider, 1977).

However, given level 2 verbalisation, if the conditions for its verbalising are not met, that is, if the subject is required to articulate information that is not heeded in the normal course of processing or the information cannot be encoded easily in a verbal code, the model predicts that verbalisation changes the structure of the cognitive processes.

In regard to level 3 verbalisation, Ericson and Simon contend that accuracy of performance is endangered only when subjects are asked to verbalise specific information such as reasons and explanation. At this level subjects are forced to change their thought sequences in order to verbalise the information requested. Therefore, it is only at this level that instruction to verbalise may change the process of thinking and its very nature.

### **3.1.2.3. The Completeness Of Verbal Reports**

A third important question raised concerning the theory of verbalisation includes two subquestions that ask whether such accounts are complete (Sternglass and

Pugh, op.cit.; Garner, 1982; Bereiter and Bird, op.cit.) and correct. For example, Bereiter and Bird state that thinking-aloud protocols are relatively impoverished compared to the data obtained in more calculated activities. They then conclude that such protocols probably 'reveal only certain elements of the strategic activity going on during reading, perhaps only those that involve some break in the continuity of reading, as caused, for instance, by a difficulty in comprehension' (P:132).

Within their verbalisation model, Ericson and Simon identify three causes for the incompleteness of verbal reports namely: non-availability; non-reportability; and non-retrievability of information.

#### **3.1.2.3.1. Non-Availability Of Information**

As the model predicts if the information is not heeded by the STM and therefore not stored in short term memory, then it will not be accessible for verbalisation. The criterion accounts for circumstances wherein information about ongoing processes may not simply be available in STM. One of these instances as Ericson and Simon maintain, is for example when familiar information is required to be retrieved from STM. According to Ericson and Simon, familiar words, faces and objects do not remain in STM and could be recognised without resorting to STM.



Therefore, frequently subjects do not report intermediate stages leading to 'generating interpretations and hypotheses for complex visual stimuli' (P:236).

Another pertinent issue is Shiffrin and Schneider's (op.cit.) distinction mentioned earlier between automated and controlled processing. Based on the distinction, Ericson and Simon postulate that many highly overlearned processes operate automatically and do not leave any trace in STM except their final results.

#### **3.1.2.3.2. Non-Reportability Of The Account**

The second cause of the incompleteness of verbal reports is traced to the fact that not all the information in STM is reported at the time of verbalisation. The main concern with the non-reportability of the account is indications that subjects under study tend to stop verbalisation when they are under a high cognitive load. Evidence for such failure comes from 'reorganisations of the problem representation or strategy' (Durkin,1937 cited in Ericson and Simon, 1993) and direct expressions of feeling difficulty (Johnson, 1964 cited in Ericson and Simon, 1993).

Another reason for the incompleteness of verbal reports according to Ericson and Simon is one which explains why information available in focal attention in STM is not verbalised. The assumption within the model is that the verbal report is

based on the information available to the subject at the time of report. Therefore, any time delay, say, a few seconds, may cause information to be obliterated and thus make it unattainable to verbalisation if subjects are required to perform certain types of processes, for example, repeatedly performing a particular action such as adding a number to a given number (see Ericson and Simon, 1993).

#### **3.1.2.3.3. Non-Retrievability Of The Account**

Ericson and Simon propose a third possible cause for the incompleteness of verbal reports and postulate that not all the information previously available in STM has been kept in LTM and may be retrievable from LTM. They state that the degree to which information is retrievable from LTM depends on what cues and probes are provided. What is clear is that 'memory retrieval is fallible and sometimes leads to accessing other related, though inappropriate, information' (Ericson and Simon, P:239).

As Sternglass and Pugh have suggested, these limitations may influence the completeness of verbal reports but this does not mean that the limitations invalidate the report. Accordingly, as Duncker (1935 cited in Borsh, op.cit.) maintained, protocols are reliable for what they contain positively but not for what they omit. However, to compensate for memory fallibility and the information lost due to wrong elicitation of information from STM, it is recommended that other

sources of information be used with the information obtained from introspection (see Cohen and Manion, 1980 for a discussion of multi-method approach to research in education).

#### **3.1.2.3.4. Inferences From Verbal Data As Indication Of Their Correctness**

A second subquestion of the 2.2. section pertains to whether inferences from verbal reports are correct and/or relate to cognitive processes. Critics of inferred verbal data cast doubt on whether verbal reports are related to the cognitive processes thus proposing that verbal reports are *epiphenomenal*, that is, they are produced independently of the underlying cognitive processes (Ericson and Simon ,1984; 1993). The criticism is addressed in Ericson and Simon's model of concurrent verbalisation in which cognitive processes are predicted to be in direct correspondence with verbal reports.

Their model assumes that in a problem solving task for instance, in order to understand how a subject solves a problem or predicts an answer, we need to assume that at least one processing model is responsible for and capable of generating the solution. We also need to presume that the verbalised information is produced by processing models that can generate the same information. Then, 'if we can show that the information processes that are needed to reproduce the verbalised information are also required and/or sufficient to generate the answer or



solution, the argument for epiphenomenality is essentially refuted' (Ericson and Simon, 1993; P:170).

Other criteria proposed by Ericson and Simon (1993) in regard to the above criticism are *relevance* and *memory* criteria. The former postulates that if all observed verbalised information is irrelevant to the task, then the criticism of epiphenomenality of verbal reports is correct. However, a considerable amount of research exists in the literature that indicates that verbalisations are relevant to the given task (cf., for example, works in thinking aloud experiment accompanied by eye-fixation to support inferencing processes all referenced in Ericson and Simon, 1993; see also Newell and Simon, op.cit. for an *a priori* task analysis which shows what information is relevant to task performance)

The latter criterion accounts for the fact that a subset of information attended during task performance will be recalled. It is argued that much of the information heeded during thinking aloud can be available for subsequent retrieval when subjects are asked to give retrospective reports. The verbalisation of the same information at two different parts of a protocol is indicative of the fact that similar cognitive processes are generating information already stored in STM. Looking at the process in reverse would postulate that:

'if information is recalled from memory then it must have been heeded. This implies that a model accounting for retrospective reports must also account for the original storage and the recall of the information in the reports. Information retrievable from LTM when requested by instruction should also be available to the subject when found useful in other situations. In these cases it seems unlikely that the stored information would be epiphenomenal in relation to the processes going on when it was stored' (Ericson and Simon, 1993; P:183).

### **3.1.3. Summary**

This section first discussed human memory (STM and LTM) based on the human information processing system. Then based on the relationship between thought processes and their representation in STM and LTM, the position of concurrent verbal reports within the IPS was examined. Also three main criticisms levelled against verbalization, that is, the accessibility of the mental processes to verbal report, the effect of instruction on the mental processes and the completeness of the verbal account were examined. As to the accessibility of the mental reports, it was established that controlled processes and declarative knowledge are more prone to be accessible in STM than automatic processes and procedural knowledge. Regarding the second criticism, three levels of verbalizations were discussed in which explanations about the mental processes and their rationalization were created. At level three, verbalizations were said to have effects on mental processes. As for the third criticism, three conditions were explained as the cause of incomplete verbal report, namely the non-availability of information which does not remain in STM to be reported, non-reportability of information caused by high cognitive load and reorganization of a problem, and

non-retrievability of information from STM caused by memory fallibility or failure which sometimes retrieves other information from the LTM .



# THEORETICAL BASES OF SECOND LANGUAGE READING

## Section II

### 3.2.1. Introduction

The following section deals with various important reading theories on which the present study is based. First, it justifies the researcher's choice of an interactive approach to reading comprehension by comparing it with other models of the comprehension process. Second, it briefly examines the reading comprehension theory on which the present study is based.

### 3.2.2. Approaches To Reading Comprehension

Reading research has so far adopted one of two approaches: the *psychometric* approach and the *cognitive* approach (Hill, 1988). The psychometric approach considers that reading comprehension comprises a number of sub-skills. The approach holds that statistical analyses of readers' responses to reading comprehension tests reveal a number of factors comprising comprehension (e.g. factorial analyses in Oller, 1983). The approach is, however, laden with problems in terms of defining underlying constructs such as proficiency (cf., Bachman, 1990).

The cognitive approach, on the other hand, deals with identifying and exploring how textual features interact with the reader's processing system. It is mainly related to how readers process text and bring their cognitive structures to text processing. It does this by analysing readers' recall protocols in terms of how these are affected by certain variables such as textual features, cognitive structures or processes (Hill, op.cit.). The approach also is interested in text representation in memory and the variables which affect the learning and recall of text.

Research in reading comprehension during the last few decades was more oriented towards understanding how information of any sort, including graphic symbols, is processed (Pearson, 1984). The different psycholinguistic models which have so far been proposed are an indication of this trend in reading comprehension research. Reading comprehension research has so far identified three basic recognised models of reading comprehension processes, namely, bottom-up, top-down, and interactive approaches.

### **3.2.2.1. Bottom-up Approach**

Influenced by Gough's (1972) model of reading process in L1, early work in ESL reading assumed reading to be a passive, bottom-up process. In Gough's model, reading begins with an eye fixation. The eye makes saccadic

movements, regress and moves forward. This set of motions culminate in the formation of an icon (see figure 3.2.).

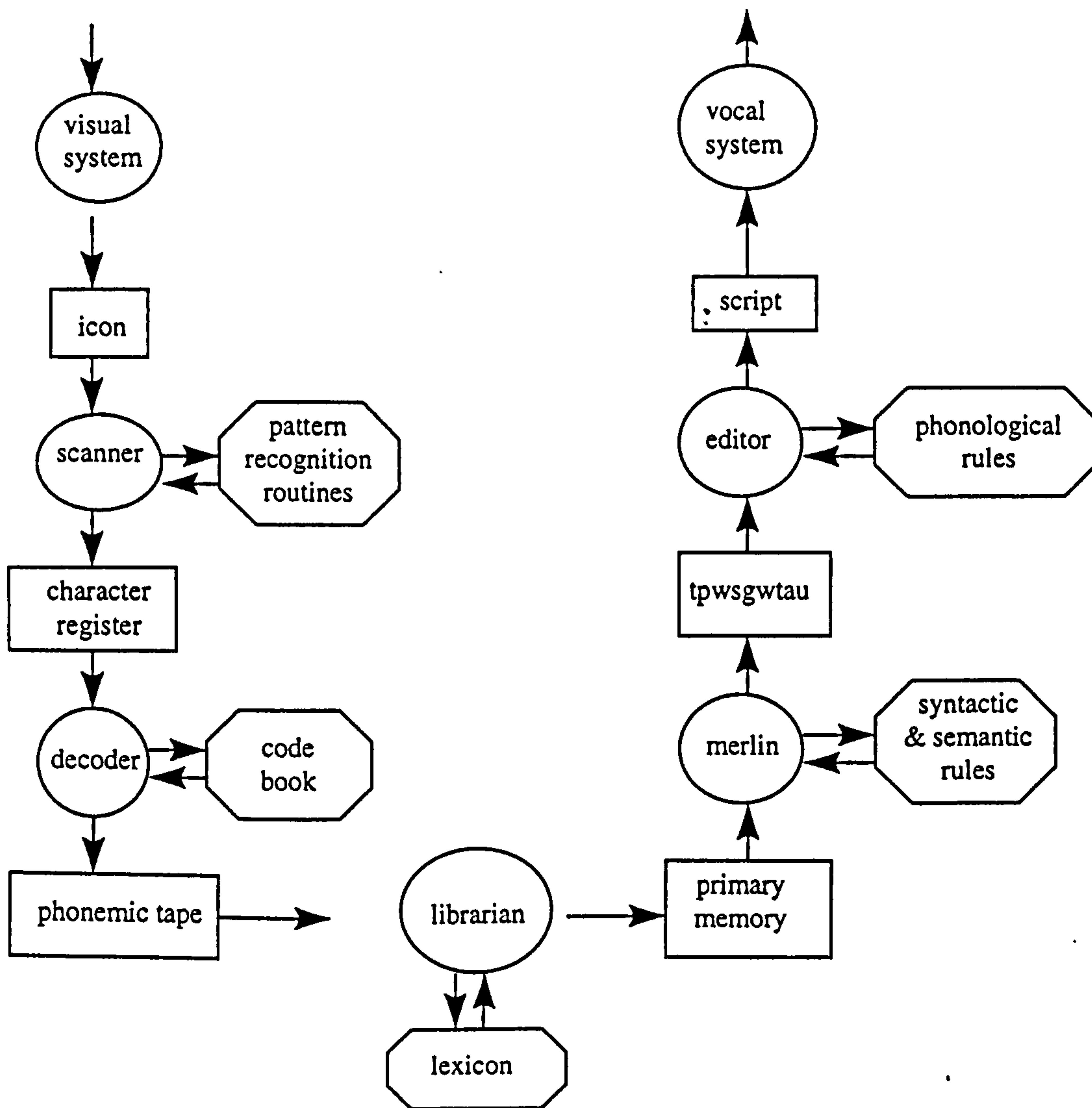


Figure 3.2. The bottom-up reading model proposed by Gough (1972)

The icon is a direct representation of a visual stimulus, that is, a word. Whatever it is, the icon has a limited capacity and can hold at least 17 to 18



letters which persist for several seconds when it is replaced by the icon arising from the reader's second fixation. Letters are then identified and read out of the icon at a rate of 10 to 20 milliseconds. Therefore, the letters in the icon emerge serially, one every 10 to 20 milliseconds into some form of character register. The next step, according to the model, is mapping print to meaning. Gough assumes that the contents of the character register are transposed into abstract phonemic representations. Gough does not determine how the lexicon is understood. However, he hypothesizes that the abstract phonemic representation is assigned the first lexical entry that can be found. The lexical search is hypothesized to be a parallel process. Once the first entry is located, its contents are accepted as the reading of the word. The next phase is to organize the contents of the lexical entry into a sentence. But before this happens, the contents of the lexical entries ranging from 4 to 5 items are maintained for a matter of seconds in a section called primary memory. The contents of lexical entries include phonological, syntactic, and semantic information deposited in the primary memory, one entry to cell. In order for the contents of the primary memory to be formed into a sentence, Gough assumes that 'some wondrous mechanism' which he calls *Merlin* operates on the information in the primary memory and tries to discover the deep structure of the lexical items, and the grammatical relations among its parts. If this is done successfully a meaningful interpretation of the contents of the lexical entry is obtained. The meaning is, then, placed in a section called *The Place*

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*Where Sentences Go When They Are Understood* (PWSGWTAU). As Gough explains:

'[a]ssuming success, the obtained deep structure provides the basis for the formation of a superficial structure containing the formatives from primary memory; application of phonological rules to this structure will yield instructions for the pronunciation of the fragment, and the reader will begin to speak' (P:519).

The main problems with the model are the following: a) the model does not take into account the problem of integrating sentences and propositions (Mitchell, 1982); b) there is no place for higher-order processes such as employing background knowledge to text processing as well as inferencing, hence cognition is effectively isolated from perception (Hill, op.cit.); c) as O'Malley and Chamot (1990) maintain, the bottom-up processing slows down the lexical access from long term memory since lack of context does not narrow the range of possible meanings that must be explored in LTM. That is, 'the route through memory pathways to the specific word meaning will be quicker if the context is provided' (P:36); d) more specifically, and from the view point of eye movement, the model does not say much about how eye movements are controlled in reading and whether the eye movement might be influenced by other aspects of text processing (Rayner and Pollatsek, 1989); e) furthermore, as Mitchell (1982) contends, the model does not predict other possible ways of text processing for readers who use different strategies in different reading tasks, thus the model lacks flexibility that is attributed to the

reader. However, the model deserves attention as it makes clear predictions about reading process that could be tested (Rayner and Pollatsek, op.cit.). Reading comprehension in a second language from the above perspective was, therefore, treated and defined as a series of decoding operations (Carrell, 1987).

### **3.2.2.2. Top-down Approach**

Influenced by the early psycholinguistics reading research (Goodman, 1967; Smith, F., 1971), the late 1970s' works in ESL reading comprehension underwent a radical change in its theoretical tenets whereby ESL reading comprehension was no longer seen as a simple passive decoding process. It was rather regarded as an active top-down process which represents 'an attempt by the brain to find an existing knowledge structure to superimpose onto the incoming data in order to facilitate more quickly the assimilation of this new information' (James, 1987; P:178). Goodman describes the model as following:

'Reading is a selective process. It involves partial use of available minimal language cues selected from perceptual input on the basis of the reader's expectation. As this partial information is processed, tentative decisions are made, to be confirmed, rejected or refined as reading progresses. More simply stated, reading is a psycholinguistic guessing game. It involves an interaction between thought and language. Efficient reading does not result from precise perception and identification of all elements, but from skill in selecting the fewest, most productive cues necessary to produce guesses which are right the first time' (P:108).



According to the above definition, the skilled reader relies less on textual input or 'visual information', to use Smith's (op.cit.) term. He is instead more engaged in selecting and sampling those linguistic elements that are important in reconstruction of meaning. The top-down approach regards the skilled reader as an active processor of textual information avoiding tedious stages of letter-by-letter and word-by-word perception. The success of the reader's strategy depends on his non-visual information (that is, background knowledge) in sampling the natural redundancy<sup>1</sup> of the language and upon his own knowledge of linguistic constraints (Hill, op.cit.). Thus, the skilled reader is the one who is involved in a continuous process of predicting, sampling, checking and revising. To avoid vagueness, let us explain the Goodman (1970) model of reading as it appears in figure 3.3.

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<sup>1</sup>The idea of redundancy is explained by Smith, F.: 'Knowledge of redundancy constitutes a readily available, internalised source of information ... more meaning can be extracted and greater comprehension can be gained from the same number of visual features if syntactic and semantic sequential redundancy can be applied' (P:201).

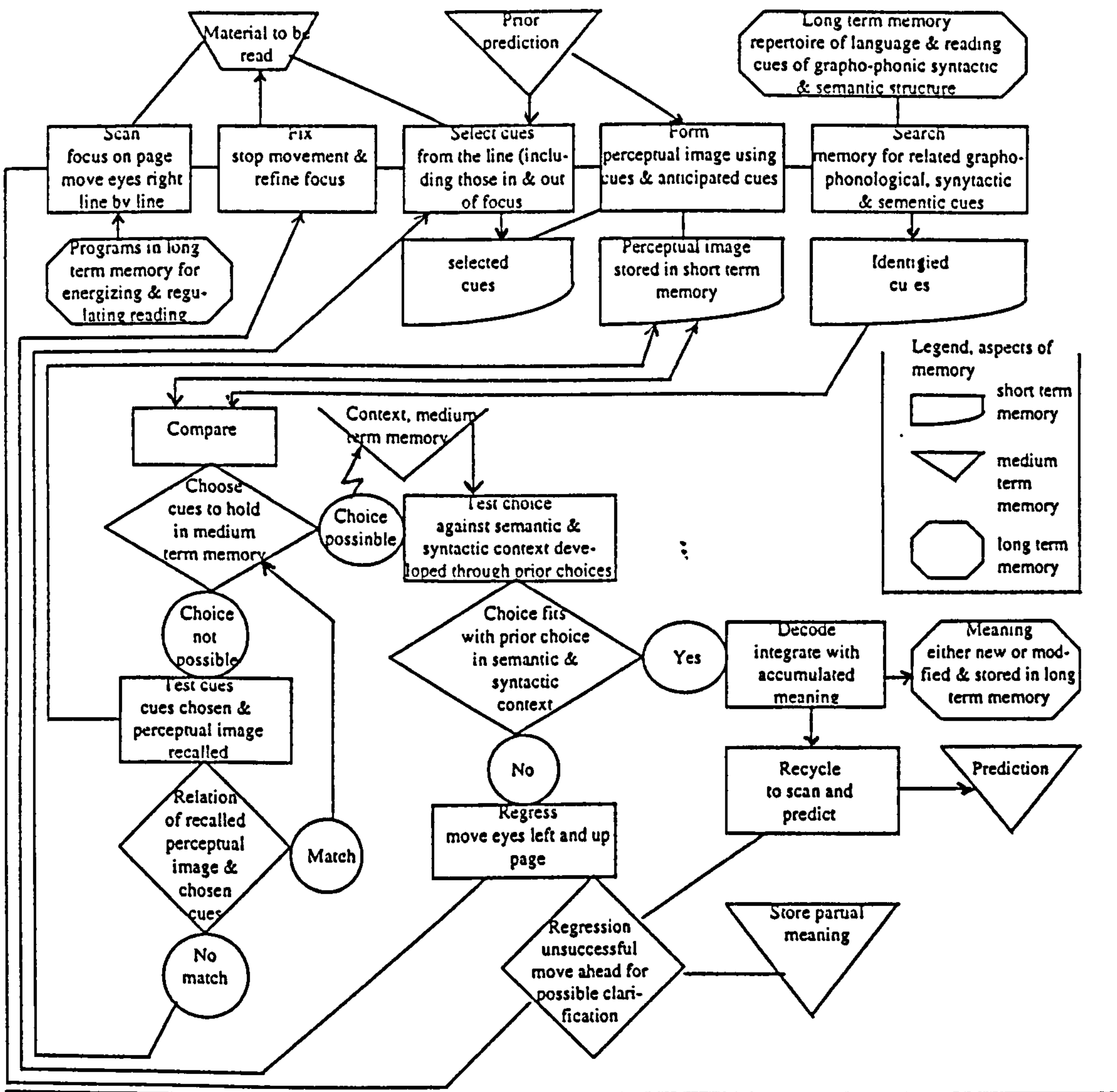


Figure 3.3. Goodman's (1970) model of reading comprehension

As Goodman (1977) explains, comprehension depends on three kinds of information: grapho-phonetic, syntactic, and semantic. According to the model, reading begins with an eye fixation on the material to be read. After *graphic cues* are selected from the material, the reader forms a *perceptual image* based on the information obtained from graphic cues. A number of factors such as

the reader's previous knowledge, and strategies help the reader to select visual information. In other words, contextual information obtained from the previous reading plays a role in the reader's selection of visual information. Smith calls this 'redundancy' inherent in texts. Next, the reader searches his/her memory for related grapho-phonological, syntactic, and semantic cues and makes use of them to help the perceptual image. At this stage, the reader attempts to make a tentative choice (or a guess) which is in correspondence with the graphic cues. If the guess or the tentative choice proves successful, it is kept in a section called *medium-term memory*. If the reader fails to make a successful guess, s/he regresses to the earlier text. The successful choice, on the other hand, is tested against semantic and syntactic context developed through previous choices. If the choice fits in with prior choice in semantic and syntactic context, then it integrates with prior meaning developed from the text and the results are stored in long term memory. A hypothesis (or prediction) is, then, formed about the forward material.

The model is in fact based on miscue analysis by beginning readers. An important feature of the model is that it can be applied, as Goodman (1988) claims, to skilled readers as well. In addition, it applies not only to all stages of development but 'to reading in all languages and all orthographies' (P:20).



Nevertheless, certain criticisms are levelled at the top-down approach by reading researchers. More generally, Lovett (1983 in Hill, *op.cit.*), for example, points out that the approach is inadequate due to its failure to produce testable hypotheses. Lovett says: 'There is considerable variability in the extent to which sampling theories have been willing to operationalize the model ... there is as yet no convincing evidence that reading is, in fact, a partial processing operation' (P:4). Eskey (1986) suggests that such models tend to downplay the importance of the text itself often by such comments as the one which says that reading is only incidentally visual. More specifically, Mitchell (*op.cit.*) contends that Goodman's model does not specify much about the reading process. The model, moreover, does not show how the various non-visual sources of information are inferred and utilized to form perceptual images. He also observes that the relevant literature provides no evidence that the reader's anticipation influences the processes that precede word recognition. Furthermore, at the word recognition level, the model refers to some sources of information which can be used to make a tentative choice concerning the identity of the word, none the less, the model does not show how such information is utilized to facilitate the choice and it does not show which types of information are more important than other types (Rayner and Pollatsek, *op.cit.*). In spite of all this, the model deserves attention in that it makes a clear proposal that 'reading is a predictable process' (Rayner and Pollatsek, *op.cit.*; P:464).

The shortcomings of the two previous models resulted in the emergence of a third approach. Thus, the two above views are now seen as being complementary (Carrell and Eisterhold, 1983; Carrell, 1987).

### ***3.2.2.3. Interactive Approaches***

This third approach is called interactive (Rumelhart, 1977) wherein efficient ESL reading comprehension requires one to implement both bottom-up and top-down processing operating interactively. Different models of reading comprehension as an interactive process are proposed. Rumelhart's famous model of reading as an interactive process comes originally from inadequacies observed in bottom-up and top-down models. His theory is based initially on powerful experimental evidence against the bottom-up model of Gough in which information flows strictly from lower to higher levels. Rumelhart builds up his theory based on the following premises: a) the perception of letters often depends on the surrounding letters; b) our perception of words depends on the syntactic environment in which we encounter the words; c) our perception of words depends on the semantic environment in which we encounter the words; d) our perception of syntax depends on the semantic context in which the string appears; e) and finally, our interpretation of the meaning of what we read depends on the general context in which we encounter the text.

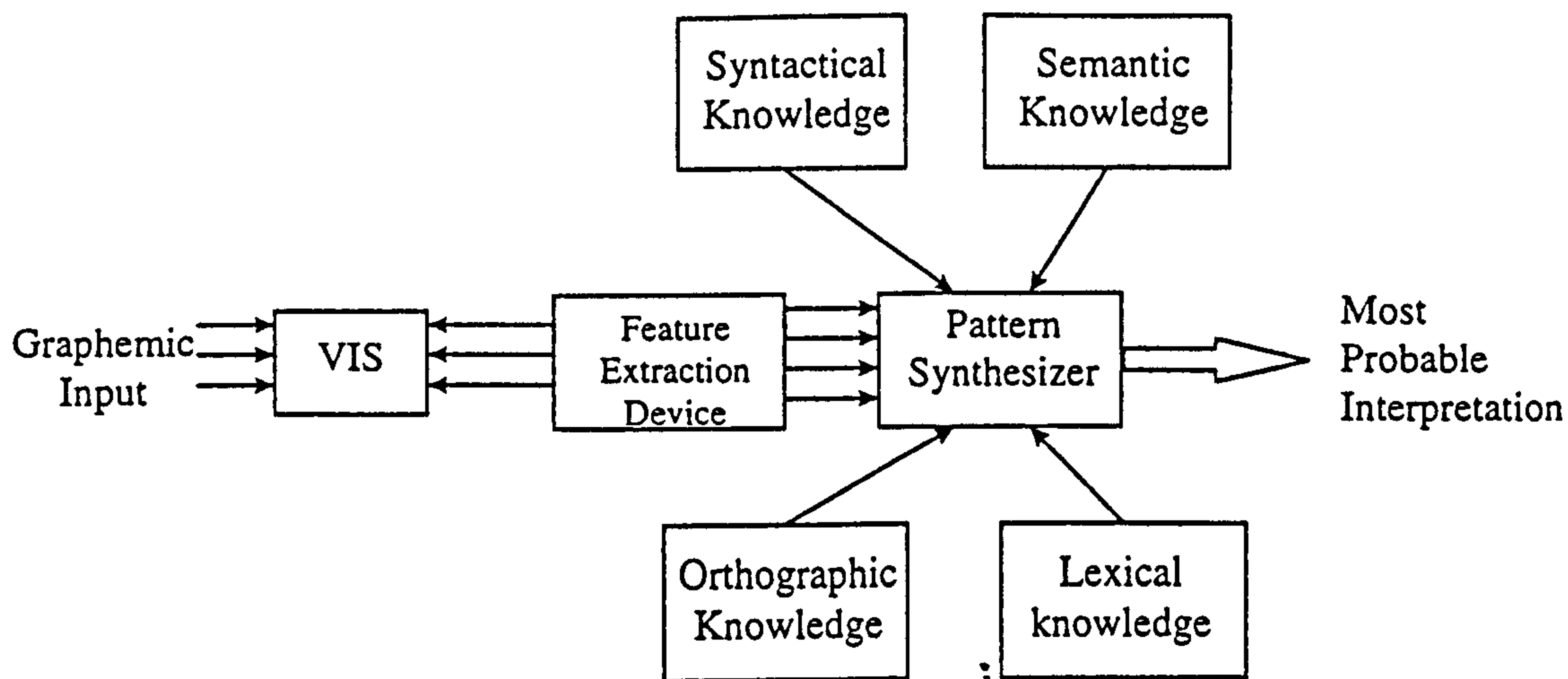


Figure 3.4. Rumelhart's (1977) interactive model of reading

The view supported by evidence on the above issues (see Rumelhart for a full explanation about the above points) reveals that our apprehension of information at one level of analysis can often depend on our apprehension of information at a higher level. As Rumelhart puts it: 'we cannot first perceive the meaning of what we read and only later discover what the sentences, words or letters were that mediated the meaning' (P:587).

Rumelhart's model begins with a bottom-up processing in which *graphemic* information enters the system and is stored in a visual information section called (VIS) (see figure 3.4.). The critical features of this information are then extracted from the VIS by a *feature extraction device*. The information stored in the feature extraction device then enters a *pattern synthesizer* which



includes information about orthographic, lexical, syntactic, semantic and pragmatic structures of the language. It is there that an interaction operates on the available information to produce 'a most probable interpretation' of the graphemic information (P:588).

It is important to notice that the operations in the pattern synthesizer occur in a parallel interacting form. To represent such a parallel interacting process, Rumelhart proposes a message centre which is the place for all such parallel processing. Independent knowledge sources which relate to the sources of input to the pattern synthesizer contain specialized knowledge about some aspect of the reading process. The message centre contains 'a running list of hypotheses about the nature of the input' (P:589). The message centre is constantly scanned by each knowledge source for the appearance of hypotheses which are related to it. Once a hypothesis enters the message centre, it is evaluated by its relevant knowledge source. Accordingly, a hypothesis may be accepted or rejected and even removed from the centre and a new hypothesis can be added to the message centre. Whenever a decision is reached, then the most probable hypothesis is determined.

The interactive model presented by Rumelhart is not a comprehensive model of the reading process (as he himself acknowledged) since several important things are not shown in the model, one being its inability to specify the relative

importance of the contribution of the various sources of knowledge (that is, semantic, syntactic, orthographic, and lexical). The 1977 model does not either refer to the issue of skilled vs. poor reading comprehension and of individual differences.

This latter point which had remained as a serious problem within the interactive models of the time, was tackled by Stanovich (1980) with his *interactive compensatory model*. The problem, as Stanovich complains, is that few authors have discussed the relation of the interactive model to current theorizing on the nature of individual differences in reading fluency. Put simply, the current interactive models of the time were not able to account for the situations when a poor reader relied on contextual information more than on lower-level processes.

The theory postulates that the various component sub-skills of reading can operate in a compensatory manner. The theory assumes that a process at *any* level can compensate for deficiencies at any other level. This means higher-level processes can actually compensate for deficiencies in lower-level processes. An example would be a reader with poor word recognition abilities who may be more reliant on contextual factors since contextual factors provide the reader with additional sources of information. As Stanovich rightly argues, such a compensatory mechanism is not considered by most top-down models

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of reading (e.g. the Goodman model, 1970). In top-down models, higher-level processes (or hypothesis-testing based on contextual expectancies) are usually less involved in poor readers' performance. Poor readers are thus less facile in their use of contextual redundancy, make few hypotheses which are often incorrect, and rely more on visual information in order to recognize a word. In like manner, bottom-up models contain no such a compensatory mechanism since bottom-up models like top-down models assume that good readers use higher-level processes better than readers with poor reading abilities.

In 1984, Rumelhart attempted to elaborate another interactive model in which the notion of *schemata* was introduced. According to Rumelhart (1984), the schema theory is a theory of knowledge and a theory about the way knowledge is represented and about the way such a representation can help its use in particular ways. He assumes that 'all knowledge is packaged into units' (P:2). These units also contain information about how this knowledge is to be used. The main function of schemata is in the formation of an interpretation of an event, object or situation in the process of comprehension.

Similar to the 1977 model, the new schema theory assumes that comprehension is the result of an association of a primary activity with its relevant schema which determines an adequate account for some aspects of a



given situation. For example, a reader with poor knowledge of vocabulary may have problems with associating a given word with its schema, since there is no data structure for representing that word in memory. The reader is free to accept the schema as adequate despite its flawed or to reject the schema as inadequate and search for another possibility. When each schema source enters the message centre (not mentioned here but is implicitly referred to), a process of hypothesis-testing, and evaluation of goodness of fit occurs. Comprehension occurs whenever a configuration of schemata (hypotheses) is formed which offer a coherent account for the various aspects of the text. If such a configuration is not found, the text will appear incomprehensible.

The schema model proposed by Rumelhart shares some characteristics with Goodman's (1970) top-down model in which the reader engages in hypothesis-testing process. However, while the reader in the Goodman model confirms the hypothesis by minimally sampling the visual information and generating a new hypothesis about the next material, the schema theory stays away from less reliance on graphic cues.

A recent development in interactive reading model based on eye movement research is Rayner and Pollatsek's (1989). Like Rumelhart's (1977) reading model, their model begins with a bottom-up processing which interacts with top-down processes, thus making it an interactive model or what Davies, F.

(1995) calls bottom-up interactive. An important feature of the model, in contrast to other models is reflected in the writers' attempt to make an explicit relationship between eye movements and other reading processes.

Figure 3.5. represents the different aspects of the reading process according to Rayner and Pollatsek. In the model the circles stand for observable activities, whereas the boxes represent processing activities. The processing sequence begins with an eye fixation which includes initial encoding of the printed words. The initial encoding process involves two processes which occur in parallel, mainly, *foveal word processing* and *parafoveal processing*. Foveal vision which refers to the central 7 characters around the fixation point deals with processing the letters of the word that the eyes are fixated on. Parafoveal vision which refers to the central 11 to 17 character spaces around the fixation point is concerned with 'extracting visual information to the right of fixation' (P: 427). Therefore, parafoveal processing gives the reader information about words, letters, and word length that is used in specifying where to look next. Therefore, its role is facilitative in lexical access occurrence. This means, a reader can speed the lexical access processing particularly when such processing is aided by a parafoveal preview of the letter information from the prior fixation.

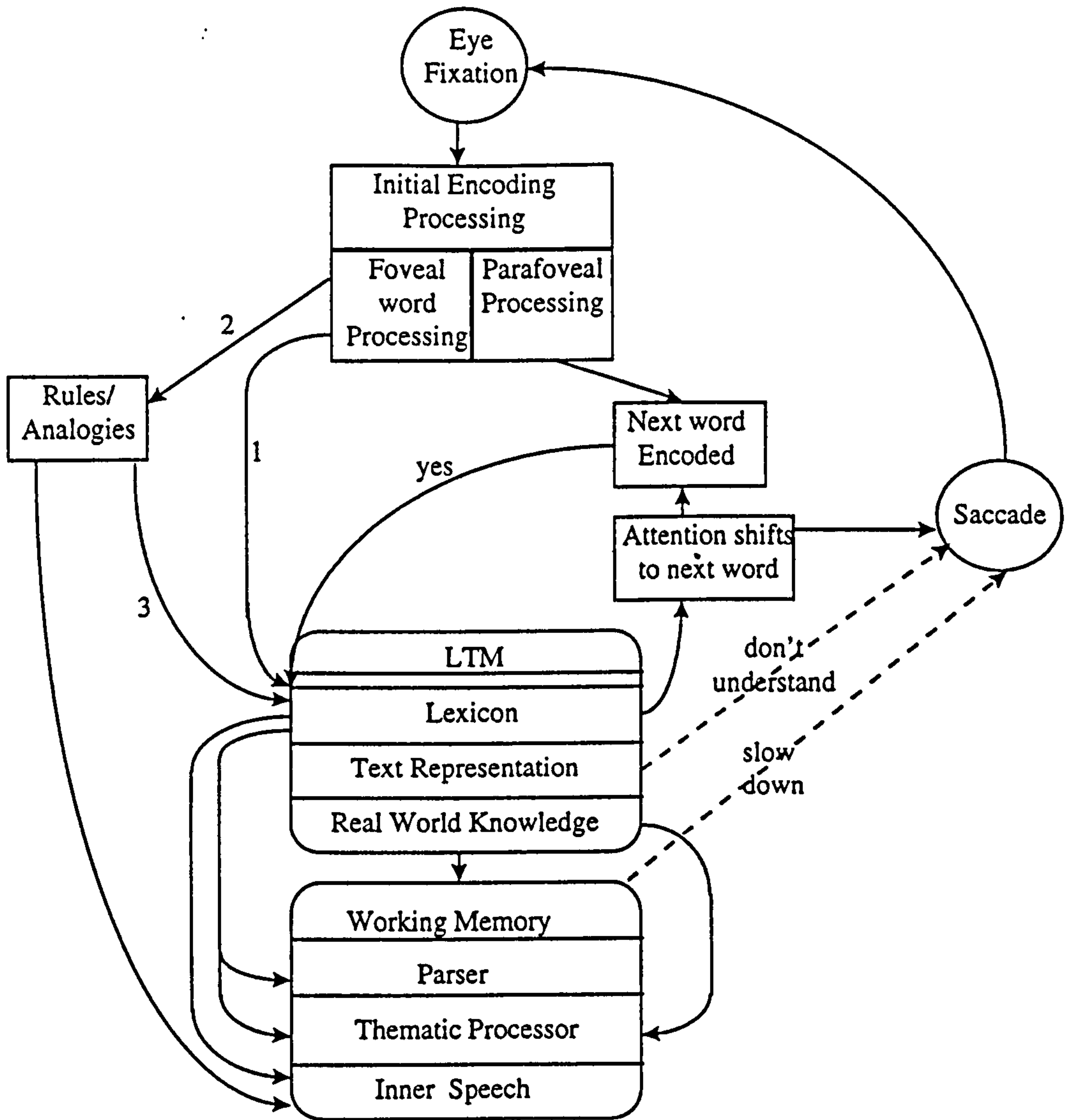


Figure 3.5. An interactive reading model proposed by Rayner and Pollatsek (1989)

As for lexical access, the model predicts two routes: a direct route shown in the figure by digit 1 which involves a direct processing of lexical access from foveal word processing to lexicon section in LTM, and an indirect route (or



rules and/or analogies which create an auditory code) shown as digit 2.

Lexical access occurs through one of these routes

The position taken by Rayner and Pollatsek makes a clear explanation in which 'direct visual look-up' process, whereby the letters access a word in parallel, appears to be a necessary ingredient of fluent word identification. Sound encoding appears to play some part in accessing the meaning of words in fluent reading. The sound system may matter only for processing a few low-frequency words. Their position is consistent with a 'co-operative computation model', wherein entries in the lexicon are excited both by the direct visual route and by the indirect route to sound route, with the recognized word being the entry that has accrued the most lexical excitation. As is shown in figure 3.5., both the indirect route and direct route from the lexicon activate an acoustic representation in the *inner speech* section which consists of articulatory movements (that is, subvocalization) and phonological codes (or mental representations of speech that can give rise to the experience of hearing your voice) with the former making the latter much easier. According to Rayner and Pollatsek, phonological codes appear to be activated for most words we read and this phonological information is held in working memory and is used to comprehend text.

This use of phonological codes is an instance of interactive processing. Creating an acoustic or speech-like representation in the short-term memory may be helpful for other processes that are being executed. Since new words are processed very quickly, one would soon overload his/her short-term capacity if words were not chunked together in meaningful ways in working memory. Words in their phonological codes are held in working memory until meaningful units are passed on to long-term memory. Since sentences have often long distances between related words, such phonological representations help us to reinterpret an earlier section of a sentence in light of words that occur later in the sentence. Therefore, there is an interaction between phonological codes in working memory and other processes involved in lexical access and restructuring and reinterpreting the words in light of new information in working memory.

Phonological codes may aid comprehension through information about *prosodic structure* (that is, rhythm, intonation, and stress). Citing Slowiaczek and Clifton (1980), Rayner and Pollatsek argue that while prosodic information is available in auditory language processing and aids listeners in sentence comprehension, written language provides impoverished cues. Therefore, the reader must find some way to compensate for the lack of prosody in reading and reorganize the sentence into a prosodic structure. As Slowiaczek and Clifton contend, this is a role of phonological codes in

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reading. When lexical access of the fixated word is finished, attention shifts to the next word to the right of fixation which is followed by an eye movement to the next word. Upon successful lexical access the meaning of the fixated word is integrated into a text representation in working memory. Working memory consists of different sub-components used in understanding text. It consists of the inner speech mechanism, a parser which functions to structure a syntactic representation, and a thematic processor which provides an ongoing semantic representation.

As was said, according to the model, the main function of the parser is to parse strings of words into their appropriate syntactic constituents. In so doing, the parser employs strategies such as *minimal attachment* and *late closure*. The strategies are primarily based on one particular theory of parsing: the *garden path* model of sentence processing (Frazier and Rayner, 1982 in Rayner and Pollatsek). According to the model, words in a sentence are assigned an initial syntactic analysis based on structural information. Based on the two general strategies mentioned above, a phrase structure representation of a sentence is formed which allows the reader to incorporate each new word into it. As is implied from the 'minimal attachment' phrase, the reader uses 'the fewest nodes consistent with the well-formed rules of the language under the analysis'



(P:246) attaching new information into the phrase marker being constructed<sup>2</sup>.

According to the *late closure* principle, the reader attaches new items of information to the phrase or clause currently being processed. Rather than attaching new items to subsequent items, it applies them to the preceding items<sup>3</sup>.

Rayner and Pollatsek propose a *thematic processor* which operates on the output from the parser and monitors the semantic content of the material by selecting the best semantic and pragmatic interpretation of the text from among alternative thematic interpretations. However, the thematic processor, as it is discussed by Rayner and Pollatsek, works somewhat independently from the parser. Therefore, the process is basically bottom-up, going from

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<sup>2</sup> An example to exemplify what is meant by minimal attachment is given by Rayner and Pollatsek in which the reader initially takes the phrase *the answer* as the direct object of the verb *knew* in the following sentences: 'The girl knew the answer by heart', and 'The girl knew the answer was wrong'. But by a further reanalysis, the reader takes the *answer* as the subject of a new clause in the second sentence since according to the application of the minimal attachment principle, this sentence has an additional node to the one in the former sentence.

<sup>3</sup> The illustration given by Rayner and Pollatsek about the following examples clarifies the notion of late closure. By employing the strategy, the reader parses the first sentence correctly but may parse the second sentence to be initially parsed incorrectly. The two examples are: 'Since Jay always jogs a mile this seems like a short distance to him'. 'Since Jay always jogs a mile seems like a short distance to him'. In the case of the two sentences, the key region is the phrase *a mile* and the word following it. When *jogs* is encountered, a verb phrase is being constructed which could take an object. When *a mile* is encountered, there is no reason to close the phrase, so that *mile* is incorporated into the phrase as the direct object of *jogs*. In the case of the first sentence, this is the correct interpretation, so the reader proceeds without difficulty. In the case of the latter sentence, since *a mile* is in fact the subject of the next clause, the reader needs to recompute the syntactic structure at *seems*, the point when the object

words to syntactic structures to semantic structures. Interaction between the parser and the thematic processor occurs only when the sentence is misparsed and needs to be reanalyzed. The reason is that the parser, according to the theory proposed by Rayner and Pollatsek, operates on 'the structurally preferred analysis of a sentence' and disregards contextual and pragmatic information. The thematic processor, on the other hand, has available to it contextual and pragmatic information (see figure 3.5. for the flow of information from real world knowledge to thematic processor) and compensates, so to speak, for the deficiency in the parsing process (see also interactive compensatory theory discussed earlier).

Construction of meaning which appears to be the result of syntactic analysis and semantic processing forms a representation of text in long term memory. If text representation is not successfully made, then the signal of 'don't understand' is sent to the eye movement system.

Bernhardt (1991, see also chapter two for a fuller report of the study) has recently attempted to analyze recall protocols of a group of second language readers within an interactive model of reading. The model she proposes includes three 'text-driven' feature (or word recognition, phonemic/graphemic

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interpretation of a mile is untenable, and thus there is processing difficulty (P:248).

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decoding, and syntactic feature recognition) and three 'conceptually-driven' features (or intra-textual perception, monitoring, and prior knowledge). Bernhardt's initiative is important since it systematically analyzes recall protocols within a well-defined set of interactive features.

While *word recognition* refers to misinterpretation of the meaning of a word, *phonemic/graphemic decoding* involves misidentification of words based on the visual or aural similarities words share with other words. *Syntactic feature recognition* was defined as the relationships between and among words (e.g. when the subject interprets present tense as past tense or singular noun as plural).

On the other hand, *intra-textual perception* relates to how the reader perceives and then relates each part of the text with the previous and following discourse context (e.g. the impact of the reader's initial decisions about the text on his/her total perception of the text). *Metacognition* refers to the reader's thinking about or reflecting on what is being read characterized in written recalls by question marks, parenthetical comments, vague vocabulary, etc. *Prior knowledge* refers to the reader's existing knowledge of the world or of particular topics that permeate the reader's recall.



### 3.2.3. Overall Critical View

The construction of reading models from Gough's (1972) model to the recent development of interactive theory signifies an important evolution and better understanding of the reading process. While Gough's model suggests a view of the reading process taking place step by step due to its uni-directional nature, holding in the bottom, it is important because many of its features can be seen in later recent developments of the reading process. His model is important since it takes into account an explanation of eye movements, though crudely, in reading process. The model also pays attention to phonological decoding, a process which appears to be absent in Rumelhart's (1977) model. Regardless, however, of all this and in addition to the problems with his model referred to earlier, the model remains ambiguous particularly with regard to how meaning is obtained through his 'wondrous mechanism' which he calls Merlin.

The contribution of Goodman's reading model (1967, 1977) to better understanding of the reading process is unquestionably definite. Its impact on reading research is shown by Bernhardt (op.cit.; P:22) who reviewed the related literature and found that of the 562 L1 citations written from 1974 up to 1988, almost 373 of the sources have referred to Goodman's model. Bernhardt challenges such dominance of the psycholinguistic model

exemplified by the writings of Goodman and argues that this can be due to the fact that there is a basic lack of awareness and perception of the capabilities of models other than those of Goodman. However, one difficulty with such models is that they have not been very explicit concerning what kinds of hypotheses are being entertained. Bottom-up processing plays a minor role. Even as to the guessing behaviour, researches in children learning to read show that the highest level of reading skill (acquired around fourth or fifth grade) does not involve guessing behaviour (or an over-reliance on contextual information) but rather quick and efficient analyses of the printed words (Rayner and Pollatsek, *op.cit.*). This evidence goes counter to Goodman's model (1967) which was originally developed to account for how children learn to read which he considers as a model of skilled reading as well. Furthermore, the model does not actually show how the meaning that is currently analysed is assimilated with prior meaning. This lack of precision concerning higher-order processing not only is evident in the top-down models, but is a characteristics of the bottom-up models as well.

An alternative way for dealing with shortcomings observed in both top-down and bottom-up models was proposed by Rumelhart (1977), who argues strongly for top-down processing absent in Gough's model as well as bottom-up processing weakly accounted for in top-down models. Certain inadequacies, however, characterize the proposed interactive model of

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Rumelhart. Like top-down models, it lacks precision about higher-order processes and does not specify the size of information used in the formation of an interpretation of an event in the process of comprehension. Later on, McClelland and Rumelhart (1986) explain in more details the way they perceive how schemata operate in text comprehension in their book called *Parallel Distributed processing*. Yet the main issues discussed deal with word recognition and higher-order processes are left largely unexplained.

Rayner and Pollatsek's interactive model is important to compare and contrast to the previous models of reading for two main reasons. First, it incorporates an explicit relationship between eye movement processes and other reading processes. Contrary to top-down models which assume that prediction in reading comprehension is formed based on the information obtained from graphic cues, the Rayner and Pollatsek model accounts for foveal and parafoveal processing which gives the reader information about words, letters, and word length that is used in specifying where to look next. Thus, compared to top-down models, the role of foveal and parafoveal processes are more of facilitation than selection. Second, it predicts a phonological route for lexical access in fluent reading. This auditory process functions as an assisting system in visual processing of text comprehension. This latter property is accounted for in Bernhardt's model of reading process.



### 3.2.4. The Theory Of This Study

The reading theory of this study is built upon previous developments in reading research theory mentioned in this chapter. As Samuels and Kamil (1988) state a good theory should *summarize* the past by synthesizing much of the information gathered in the past, and help us understand the present by eliminating the nonessential aspects of the phenomenon. Therefore, the theory used in this study contains higher-level processes as well as lower-level processes. The higher-level processes include features such as prior knowledge, metacognition, inferencing, and discourse processing while the lower-level processes comprise processes such as word recognition, phonemic/graphemic decoding, and syntactic processes.

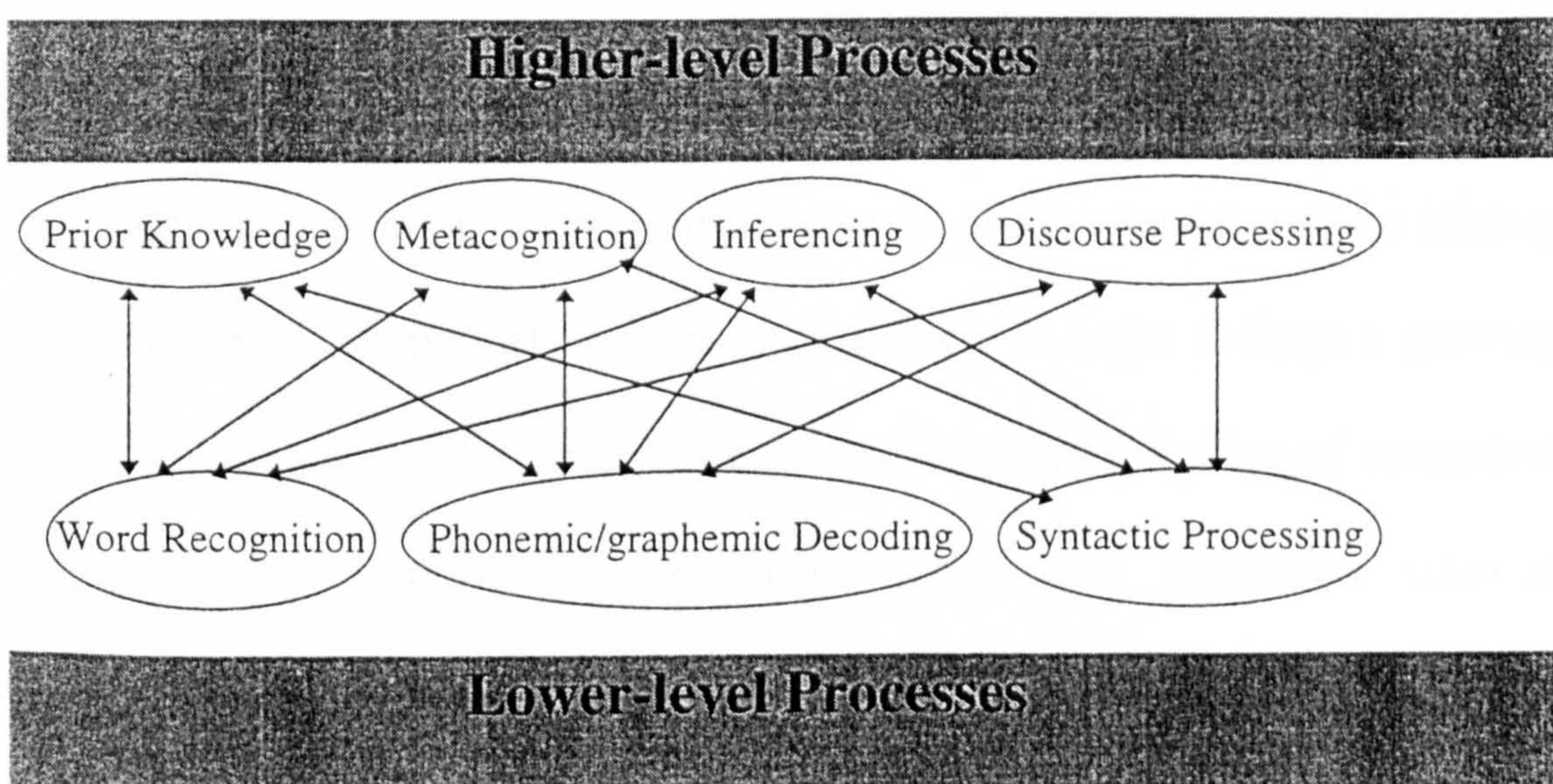
Nevertheless, interactive models and theories suggest that higher-order processing abilities play an important role in text understanding (e.g. Rumelhart, 1984). One important example of such processing refers to background knowledge or schema which has been given due consideration in Goodman's top-down model (1967) as well as that of Rumelhard (1984) and McClelland and Rumelhart (1986). Two more recent developments, that is, Rayner and Pollatsek and Berhardt have given credence to this aspect of text comprehension. Furthermore, there is a considerable bulk of research in first and second language which suggests that reading comprehension is intertwined with knowledge of the world. The necessity of appropriate

background knowledge for comprehension is easily illustrated where a text contains information from a specialised knowledge domain (e.g. see Alderson and Urquhart, 1985 cited earlier in chapter 2). From the schema theory perspective exemplified by the work of Rumelhart (1984), a text does not by itself carry meaning. It, rather, provides directions for readers as to how they should construct or retrieve meaning from their own, previously acquired knowledge. This knowledge is called *schemata*<sup>4</sup>. Background knowledge in this study refers to the reader's existing knowledge about the world, knowledge about the content of the text, and assumptions or expectations that readers may bring to the text.

Another important aspect of text processing relates to metacognition or our knowledge about process. This knowledge is comparable to what are called control procedures in computer processing (Pearson, 1984) or consecutive/metacognitive component of the reading process (Kern, 1992). 'They refer to *how* data are processed instead of *what* data are processed' (Pearson, P:3). While this aspect of reading process is shown explicitly in models such as the ones developed by Rayner and Pollatsek and Bernhardt, other models such as Rumelhart (1977), for example, take it as an implicit process in reading comprehension when they talk about the process of testing



choice and regression (c.f. Goodman's model) and evaluation of goodness of fit (see Rumelhart's model). Metacognition in this sense is a monitoring comprehension process. This is demonstrated in terms of employing strategies such as reading rate, self-directed question, controlled skipping (Sarig, 1987), and using sing song intonation to facilitate comprehension (these will be discussed in response classification schemes, chapter 4).



Figure, 3.6. A proposed model of reading comprehension

An inferencing process includes processes which involve inferencing information from surrounding context. The information inferred can come from smaller chunks of text such as word, or from longer chunks such as sentence and paragraph. This process is included in Goodman's top-down

<sup>4</sup> Rumelhart defines a schema as 'a kind of informal, private, unarticulated theory about the nature of events, objects, or situations which we face' (P:9).



model when he talks about sampling the natural redundancy of the language. The inferencing process helps to fill in the unstated or redundant information that is not explicitly in the text, thereby, helping the text 'make sense'. Therefore, the process of inferencing is a process of getting meaning from text by means of the information a reader brings to the text including knowledge about grapho-phonetic, syntactic, and semantic components of the text.

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Discourse processing, another higher-order component of the reading model in this study, relates to processing information in bigger chunks such as relating information in one part of the text to other parts in order to form a growing model of discourse. The process is the result of the contribution of successive sentences which must be determined within and integrated into an incrementally growing model of the discourse (Bernhardt, op.cit.; P:120). Furthermore, this process component of the reading model is given importance by an interactive model proposed by Carpenter and Just(1981; P:193) who call it 'inter-clause integration'. According to the model, integrating the new sentence with the old information consists of representing the relations between the new and the old structures. Such an integration is done by employing several strategies such as relating the new information to the other information that is already in working memory either because it has been repeatedly referred to or because it is recent; relating new information to a topic that is active in working memory; and relating semantic elements of

some previous information to construct main idea of text. Therefore, discourse processing is viewed as a process of generating coherent internal meaning structures demanded by a particular communicative context, that is, reading for meaning.

Interactive models emphatically indicate that lower-level processing skills are important to good reading (e.g. Rayner and Pollatsek). Therefore, lower-level processing such as word recognition, phonemic/graphemic decoding, and syntactic processing are all important ingredients of successful text comprehension. As a lower-level processing, word recognition is an indispensable component of most reading models. Unlike top-down models which downgrade the role of word recognition, this basic part of reading comprehension process is recognized particularly by bottom-up and interactive reading models mentioned earlier in this section. Word recognition process is viewed in this study as a process of slow decoding of items of vocabulary, slow word for word processing of text, interpretation of the meaning of a word either correctly or wrongly, presenting synonyms, etc. (see also response classification schemes, chapter 4).

Phonemic/graphemic decoding is also one of the frequently-cited components of reading models. The occurrence of it could be seen in Gough's model as well as the model developed by Rumelhart (1977). This component process,

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particularly phonemic decoding is given ground in Rayner and Pollatsek and Bernhardt too. Phonemic/graphemic decoding in this study concerns identification of words based on their visual and sound similarities with other words, breaking a word into graphemes in order to understand it, etc. (see also response classification schemes, chapter 4).

The last process component of reading process of this study relates to syntactic processing. While syntactic component of reading comprehension is mildly passed over by top-down models, both bottom-up and interactive models referred to in this study take it as an important component of reading comprehension process. Syntactic processing in this study is viewed as a process which involves the relationships between and among the words in a sentence. The main function of the syntactic processing is to parse strings of words into their appropriate syntactic constituents (see also Rayner and Pollatsek's model).

An important aspect of an interactive model particularly relevant to ESL reading is the notion explained by Stanovich under the term '*interactive compensatory approach*'. While both Rayner and Pollatsek and Bernhardt do not include this important aspect of text processing in their model, the notion is particularly given importance both by Carrell (1988) and Grabe (1988). Although this is not inserted into the reading model of this study, instances of



such over-reliances will be accounted for in the analysis of reading comprehension strategies.

### **3.2.5. Summary**

This section examined different psycholinguistic models of reading process. Gough's bottom-up model of reading was discussed and criticized as lacking higher-order processing. Furthermore, Goodman's theory of reading process, mainly, top-down processing was examined and its shortcomings such as inability to produce testable hypotheses, lack of precision concerning how the various non-visual sources of information are inferred and utilized to form perceptual images were discussed. The section also examined another important alternative reading process called interactive by reviewing four main developments in the field, that is, Rumelart's interactive models of reading, Rayner and Polatsek and Bernhardt's interactive model. While both bottom-up and top-down models suffer from going into an extreme over-reliance on either lower-level processing or higher-level processing, the interactive models present a modest view including a realistic account of the reading process based on experimental findings bearing on various methods of reading process investigation such as eye movement research and recall protocol methodology. The section finally discussed reading process components of an interactive theory of ESL reading which comprises four higher-level processing and three

lower-level processes used for the analysis of the thinking-aloud protocols of the present study.

# Chapter Four

## Methodology



# METHODOLOGY

## 4.1. Introduction

This section expounds the procedures for obtaining verbal report data. The sections which follow comprise specification of subjects, materials utilised in the study, and the procedures through which the study was conducted. These will be examined in turn. However, some preliminary considerations on subject specification are given importance in this chapter to make the argument more tangible.

## 4.2. Considerations On Subject Specification

To specify the characteristics of the subjects taking part in this study, it is considered appropriate to explain the subjects' learning situation inasmuch as in analysing the verbal report protocols a knowledge of the target students' learning situation and other contributing factors relevant to subjects performance on the verbal data might appear necessary in our interpretation and analysis of reading moves and strategies utilised by the subjects.

### 4.2.1. Subjects' Educational Background

Ethnically speaking, they belong to different racial groups including Turk, Persian, Arab, Kurd and Baluch. Persians and Turks constitute the main bulk

of the population and are economically more affluent than the other ethnic minority groups. By and large, such prosperity has resulted in their educational superiority over the rest of the ethnic groups.

Though coming from different parts of the country with different racial backgrounds, these populations share certain similar characteristics. A central point of commonality is that the students undergo the same national educational program and are exposed to the same educational policy as to the same course syllabus and respective text books.

As to the English language instruction, there is no English language course during the first five years of primary compulsory schooling. Students are exposed to English on their entrance into the first year of the guidance school, a three year program which functions as a transitional period between the primary schooling period and the four year period of high school. English language courses are designed on the basis of a purely structural syllabus and a somewhat weak audio-lingual approach. Weak in the sense that there are almost no English labs in schools, although they can be found in the majority of private schools, which not surprisingly only a small population of students can afford to enter.

Having been accustomed to a structural syllabus and having practised oral activities, students on their entrance into high school are exposed to a quite different method of language teaching, that is, a cognitive-code learning approach. The primacy of understanding as a meaningful system and that language should be consciously acquired is expressed through a lot of reading texts and activities. This shift of approach is rather confusing to most language learners.

Most, if not all, reading texts are geared towards English for Specific Purposes (ESP) and become more difficult, both in terms of grammatical structures and the general readability of texts, as students pass from one high school year to another.

A rough analysis of the general performance of the students shows that by the end of the high school period, the majority of the students perform more weakly than expected. This is partly due to socio-economical factors. Iraq's invasion of Iran in 1979 which lasted for eight years and the destruction of two thousands cities and villages along the one thousand miles of front line in the most populated parts of the country, the homelessness of more than two million war-victim citizens, etc. left a deep impact on the social, educational and economical structures of the country.



With regard to English language courses presented at university, the students are offered four general English credits during the first two terms and prior to an ESP course. The general English courses are aimed at providing students with general English competence particularly reading and grammatical competence. The textbooks used are '*Reading in a Foreign Language*' published by Shiraz university and '*English Sentence Structure*' known as *ESS* by Krohn (1964).

Upon successfully passing the general language proficiency courses in the first year, the students have to sit two more English language courses but this time under the auspices of English for Specific Purposes (ESP).

Students taking ESP courses are generally of three types, so to speak, or three levels. The first group is categorised as those who have entered the university with dormant knowledge of English. A great majority of this type includes students who had participated in the eight year old war either as soldiers or as volunteers. This group constitutes 40% of the total students currently admitted into universities each year. These students, due to their involvement in the war, have had little chance to practice English, hence, possess a weak English language proficiency. Nevertheless, they are highly motivated to learn English

as an international language. Socially, they belong to the low and middle class and have had little, if any, chance to take private English courses.

The second group of students is intermediate students who have acquired English language through exposure to English classes prior to their entrance to university. Their knowledge of English is obtained through formal English instruction in the guidance and high school periods.

The third portion of the student population belongs to a higher social class who have economically been able to take part in private English classes hence reveal a potential English proficiency in contrast to the two other groups.

A general common characteristic of all these students is that they can be categorised as inadequate readers in terms of the ability to read English effectively and bring appropriate strategies to use when reading.

### **4.3. Considerations On Subject Selection Procedure**

It is true that conducting qualitative research presents unique problems to the researcher (Seliger and Shohamy, 1989; Hatch and Lazaraton, 1991). One such problem concerns the selection of subjects. The first issue related to subject selection is the idea of representative informants. Some researchers like

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Alderson (1990) believe that in qualitative research of a think-aloud nature it is more important to identify good informants than to find representative informants. The reason for this, as Afflerbach and Johnston (1984) contend, is that less verbal subjects may produce less complete verbal reports than more verbal subjects (c.f., Clark, 1979 who selected his subjects from among those whose speech was relatively clear both in Spanish and in English).

Some researchers like Olshavsky (1976-77) have used teacher recommendations as regards subject selection viz. subjects who produced better verbal reports in class were assumed to be better able to provide rich verbal report data in the experiment. Regardless of how such a selection biases the sample hence endangering both external and internal validity of the data, it is argued that the data reveal only processes of 'verbal' subjects and little or no insights can be obtained about the processing of less verbal subjects (Afflerbach and Johnston, op.cit.).

Knowledge about content-area has been suggested as a criterion in selecting subjects on the assumption that with such knowledge subjects will feel comfortable with the task at hand which consequently results in high verbalness of the subjects (see for example, Chi, Glaser and Rees, 1982, cited in Afflerbach and Johnston, op.cit.).



### **4.3.1. Subject Number Constraint**

Another important issue in regard to subject selection is the number of subjects taking part in the experiment. There is a common belief that an adequate number of subjects is required for quantitative research to validly defend its data that is, their reliability and generalizability. For example, if we want to measure the extent to which reading comprehension ability is correlated to writing ability we must have an adequate number of instances to allow us to discuss the significance of the correlation. This adequacy is rooted in the requirements of educational statistics (see for instance, Hatch and Lazaraton, op.cit.).

In contradistinction to the expected notion governing quantitative research, qualitative studies including ethnography, and descriptive research employ relatively low numbers of subjects in dealing with the research question and data analysis. Seliger and Shohamy, for example, contend that concerns for the size of the subject population do not apply to research in which the objective of the research is heuristic. There are clear reasons for this. Tapping verbal report data obtained through individual interview sessions is not comparable to putting an answer key over an examinee's sheet to determine his\her score. It is rather dealing with transcribing and analysing protocol contents which more often than not take a considerable amount of time.

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The problem presents itself particularly when one is dealing with subjects in untimed sessions. For example, Johnston and Afflerbach (1985) found that their subjects supplied quite lengthy accounts (15-20 type written pages) of their strategies for a single 5-paragraph passage.

Leaving aside the scholarly investigations done in the field of second language reading which are mainly case studies using one or two subject-informants (for example, the pioneering work of Hosenfeld, 1977), the number of subject-informants in the few extensive studies (that is, at PhD level) has barely, if ever, exceeded ten. Of the three such investigations known to the present researcher one is Cavalcanti's (1983) who used four Spanish subjects in her attempt to compare strategy utilization in first and second language. The second study is Block's (1986) who asked nine students to verbalize their thought processes and the third one belongs to Sarig (1987) who utilised ten female subject-informants to get insight into strategy transfer between first and second language.

Based on the purpose of the study which seeks to compare strategy use among two groups of novice and skilled non-native readers, this study has selected 8 novice subject-informants and 8 skilled subjects. Therefore, the number of

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subjects has exceeded the average number of previous extensive investigations to ensure the objectivity of the study.

#### **4.3.2. Reportability Criterion**

The criterion of reportability was given consideration on the grounds that the more the thought processes are spelled out during the task the better and easier strategy identification and interpretation would be. Thus based on the fact that not all would be able to verbalise their thought processes properly, it was decided to consider backup informants (Rankin, 1988). The ability to provide reportability *per se*, could not be inferred from the preliminary proficiency test given to the subjects nor was there any measurement to tackle subjects reportability prior to the experiment. For this reason, instead of asking 8 novice subjects to participate in the task, it was decided to ask 20 novice subjects to contribute to the investigation. All were treated similarly but with the intention that only 8 who were more informative in the verbal report would be selected for the data analysis.

##### **4.3.2.1. Reporting Thought Processes In The First Language**

The issue of reportability bears on another concern, that is whether the subjects have to be able to express their thoughts in the second language. It can be



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postulated that if they are to do the task in the second language then one has to account for some constraints.

To begin with, the novice readers due to their limited language proficiency inevitably face problems in reporting their thoughts in a language (English) which requires one to employ a vast range of vocabulary for expressing what they have in mind. The most serious consequence of asking the novice readers to report in the second language might present itself in a form of avoidance strategy observed in interlanguage studies of discourse production (Faerch and Kasper, 1980). In addition, requiring subjects even at advanced level to verbalise in their target language may impose another additional cognitive load on the verbalization task which may divert subjects from devoting more attention to the main task which on some occasions may eventually lead to subjects' total avoidance of verbalizing parts of mind processes due to language difficulties in expressing their thought processes.

However, a criticism which is levelled against requiring subjects to verbalize in first language while reading in a second language is that it would encourage translation and other less obvious strategies (Rankin, op.cit.). However, this to the knowledge of the present researcher has not so far been tested nor is any evidence published in this regard as yet. Consequently, having weighed this

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criticism against the above three comments, it was decided to ask the reader informants in this study to report in their native language, that is, Farsi.

#### ***4.3.3. Determining Subjects' Level of Proficiency***

Determining the subjects' level of reading proficiency was one of the essential pre-experimental goals of the study without which categorising them into novice and skilled could have presented problems to the validity of the data. The best means to differentiate the skilled from less-skilled non-native readers is through standard proficiency tests utilised universally for this purpose albeit such tests tackle comprehension production rather than process.

As regards the less-skilled readers, although, given the English language curriculum both at pre-university stage and after, it was simple to guess the general performance level of the students, it was felt necessary to tackle objectively their reading adequacy through the standard means of second language testing. Therefore, it was decided to select a sample TOEFL reading comprehension test taken from *Building Skills for the TOEFL* (King and Stanley, 1983). The sample comprised six short reading passages each followed by five multiple-choice questions<sup>1</sup>. However, some caveats concerning the TOEFL test used in this study are in order. First, I decided to

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<sup>1</sup> See appendix c

choose the TOEFL test as a test of language proficiency mainly on the grounds that it is one of the most reliable tests of language proficiency used the world over. Therefore, the test at least favours the criterion of face validity. Secondly, selecting TOEFL was justified on the basis of the subjects' familiarity with its format (that is, short texts followed by multiple-choice questions) obtained throughout years of being exposed to similar reading comprehension questions administered both at school and university.

However, since the TOEFL test is used in this study as the dependent variable in this study, some basic information concerning its purpose, description and its scoring would seem necessary. Generally, the purpose of the test is that it assesses proficiency in English for non-native speakers. It is also used as a college admission and placement test. The test is a 150-item paper-pencil multiple-choice test measuring three aspects of English ability: listening comprehension, structure, vocabulary and written expression, and vocabulary and reading comprehension. Items involve comprehension of spoken and written language. The test of written English (TWE) is part of the TOEFL. However, the TWE score is reported separately on the TOEFL score report and is not added to the TOEFL score. In addition to the TOEFL international and special center testing programs, the TOEFL institutional testing program (TOEFL ITP) is available. The TOEFL ITP offers the preliminary test of



English as a foreign language (PRE-TOEFL) to measure English proficiency at the lower range of the lower level TOEFL scale score. Originally, PRE-TOEFL was designed to measure the English proficiency of students needing some knowledge of English but not planning to study abroad. The preliminary test also is used with students for whom the TOEFL would be too difficult. As far as the time is concerned, the TOEFL test usually takes three hours with TWE thirty minutes, and TOEFL ITP two hours. The results are scored by computer.

#### ***4.3.4. Selecting Subjects On A Voluntary Basis***

Selecting subjects for a think-aloud experiment poses difficulties to the investigator. On the one hand, it is not always an easy task to find subjects to participate in an interview designed for an experimental purpose. Many avoid participating in the experiment on the grounds that they do not want to be treated as guinea pigs in an experiment. Some do not see any advantage to themselves in contributing to an investigation. For others, it is viewed as an intrusion into their privacy. Lastly, some avoid taking part in a verbal report experiment inasmuch as they think they will be held accountable for the information in the text (Afflerbach and Johnston, op.cit.). Such informants, even if they take part in the experiment, may, because of stress, have problems with the reporting side of the task. For these reasons, many subjects are

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actually hesitant to disclose their weaknesses before an external investigator, hence respond negatively to the call for participation.

On the other hand, random subject selection from among university student populations, as is advocated for a valid statistical procedure, may pose its own intricacies particularly with verbal report experiments in which subjects may receive valuable feed back about their strengths and possible weaknesses (see, for instance, Block, op.cit.). For example, in selecting subjects randomly, we do not in fact know (nor has any investigation to date and to the knowledge of the present researcher been conducted to verify this) the extent to which one may harm subjects who have wanted to participate in the experiment to learn more for/about themselves but have been deprived of doing so on the basis of sheer chance outcome.

An alternative solution may be asking subjects to volunteer. The advantage of this method over the other methods is to confirm that their freedom to participate in the experiment is not endangered; to reveal to them that it is their right to get benefit from the result of the experiment; and finally to appreciate that such conscious, voluntary participation may result in better verbalisation. For example, Block reasons that such volunteers may be more motivated to

learn and more comfortable about verbalising ideas than other students might be.

The subjects were therefore selected on a voluntary basis. This was done by talking to the subjects during three class sessions about the purpose of the research. Each class had a population of 40 students. Preliminary arrangements had already been made with the lecturers of the classes so that I was able to talk to the students for 15 minutes at the end of the class sessions. Subjects taking part in this study were of two groups of novice and skilled non-native readers of English who were examined on two different occasions and at two different places.

#### 4.3.4.1. Novice Subjects

It became clear to them that their participation in the experiment would benefit both themselves and learners in general. Thus, attempts were made to arouse their motivation expounding that it was a trade-off between the present researcher who would benefit from their contribution to the experiment and the students who would learn more about their present language proficiency and their reading weaknesses as revealed through protocol analysis. It was also explained to them that they would receive enough feed-back about how to diagnose their weaknesses after the think-aloud session.



These explanations helped a lot in stimulating their motives particularly on understanding that they had been offered an opportunity not all students had been provided with. It was also explained that everything would be done in private and that nobody except the subject would be informed about the results of the session.

Luckily, twenty seven students both male and female announced their readiness to attend the interview session of whom only twenty took part in the experiment. Therefore, arrangements were made for each subject to be interviewed individually. The arrangements were made on the basis of the subject's best time.

All subjects participating at this stage were designated as novice foreign language readers. The first subject, NI1, taking part in the interview is a female undergraduate who at the time of the experiment was in her fourth year of studies in Botany at the Faculty of basic sciences, Mashhad University, in Iran. Her academic profile which was gathered prior to the experiment showed that she had successfully passed all four general, and English for specific purpose courses presented within the Iranian educational system and obtained a mean of grade C. However, the result of the TOEFL reading proficiency test showed that she was deficient in reading comprehension. Her reading

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comprehension score converted on the TOEFL conversion table was 27, far below the national TOEFL mean of 50 published by Educational Testing Service (ETS)(1994). Her TOEFL results showed that she managed to do the test up to the test item no. 51 within the forty five minutes time constraint and ticked roughly half of the test items and left the rest blank, an indication of slow reading accompanied by lack of guessing strategy. In terms of personality as her think aloud protocols reveal she was labeled cooperative that is, she tried to spell out as many thoughts as she could during the interview session.

The subject NI2 was a young male sophomore at the end of his second year of studies in the Biology department of the faculty of science, Mashhad University. He had already passed two general English courses presented at the university level plus a course of English for students of Science and had obtained a general mean of C+ within the Iranian educational system. His TOEFL reading comprehension score was thirty three which characterized him as weak reader. Interestingly enough, he answered exactly half of both vocabulary and reading comprehension questions. He played a cooperative role in the interview session.

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The third subject informant, NI3, was a sophomore female studying in the department of Biology of Mashhad University. Her academic profile showed that she had successfully passed two of the general reading proficiency courses plus a course of English for students of Science. Her mean score (C-) of the three English courses characterized her as a below average student of English language. Her TOEFL score was 30 which ranked her as a deficient foreign language learner. Her performance on the test showed that she ticked two thirds of the vocabulary section and left unanswered almost half of the reading comprehension test.

NI4 was a senior female student at the department of Botany, faculty of Science, Mashhad University. As was seen from her English language file, she had passed all English courses, both general and specific, successfully and had obtained a mean of C+. However, a point which is worth mentioning is that according to the English language policy of the Iranian Universities the students must have passed all four general and specific English courses scattered throughout the first four semesters by the end of the second year. She obviously took part in the experiment with a nearly two year distance from English classes. Yet, she was expected to develop a better reading ability since she was required to translate scientific English texts as parts of requirements of her other courses. In other words, the third and fourth year students are more



often asked to translate English scientific texts and present them as papers to the class. This naturally reinforces students language ability but may have influences on the methodological side. The result of her TOEFL score (she scored 35) shows that she is ranked as a weak English language reader. She left blank almost half of the vocabulary section and could respond to only the first 14 reading comprehension multiple choice questions. Her testing strategy showed lack of guessing strategy accompanied by a slow reading rate.

A cooperative subject, NI5 was a male senior Biology student on the verge of graduation at Mashhad University. In respect to his English language courses, he was almost in the same situation as NI4 was. His mean score of general English and the more special courses was B-. Nevertheless, his TOEFL score (he scored 30) was not better than the scores he obtained in his general and special courses. At the time of the experiment, he was preparing himself for a national master's examination in Biology.

NI6 was a male senior student of Biology at the department of biological sciences, Mashhad University. Just like NI5, he was preparing himself for a master's examination. The mean score of his previous English language courses (C-) showed that he had a dormant knowledge of English. He

obtained 37 in the TOEFL test. However, his performance on the think-aloud session indicated that he was not as cooperative as NI5.

NI7 was a third year female student of Botany at the department of Biological Sciences, Mashhad university. She had recently passed all four university English courses and seemed determined to fully cooperate in the think-aloud experiment. As her performance on the English courses showed she was a deficient learner of English (with a mean score of C). This was also supported by the test results she obtained in the TOEFL (that is, 36).

The last novice subject informant of this study, NI8, was a male third year student of Botany studying in the department of Biological sciences of Mashhad University. He had recently passed the English language courses and had obtained a mean score of B-. His score was better than the scores obtained by the previous reader informants. Furthermore, his performance on the TOEFL test (he scored 40) showed that he achieved better grades than the rest of the subject informants. His contribution to the task showed that he was cooperative.

In total there were 8 undergraduates of whom half were female while the other half were male. They were doing their B.Sc. in either Biology or Botany at

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Mashhad University in Iran. Both of the two fields are jointly run by the department of Biology and share quite a number of academic credits. Among the four female subjects two were students of Botany and two of Biology. This distribution was somewhat different among the male students of whom only one was doing Botany while the other three subjects were engaged in studying Biology. All in all, from among the total eight subjects participating in the study, three students were from the Botany field whereas five were from the Biology discipline. Among the females one was sophomore, two were senior and one was junior. Among the male, on the other hand, two were junior while two were senior. Totally, except for the only one sophomore, there were three juniors and four seniors. This distribution of subjects in terms of year of study, sex, and discipline is shown in table 4.1. below.

Total Subjects	Sex		Field		University Level		
	M	F	Bo	Bi	So	J	Se
8	4	4	3	5	1	3	4

Table 4.1. Distribution of the novice subjects in terms of sex, field and university level.

However, a point which it is necessary to note here is that English courses in their general and EST courses presented to the subjects were limited in number



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viz. two general English courses at the first year and two content-specific courses at the second year. This means that students usually had passed all the general and EST English courses by the end of the second year. No other additional English courses are offered after passing the required credits. Therefore, any difference in language proficiency may be attributed to the individual's motivation, extensive out-side class activity, etc., and not to the grade level.

#### 4.3.4.2. Skilled Subjects

Subjects participating as skilled readers were eight skilled readers doing their Ph.D. studies in different branches of Biology at different universities in Scotland. Five of the subjects were from Glasgow university, one from Paisley University, while the other two were from Stirling University. These subjects were mainly at the writing up phase of their researches. Regarding sex, all subjects were male students.

The first skilled subject, S11, was a male Ph.D. student of Microbiology studying in the Microbiology department of Glasgow University. He has just finished his second year of his Ph.D. studies and was delighted when I explained that his contribution to the experiment would help the novice readers to improve their foreign language reading comprehension. Prior to coming to

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Glasgow to do his higher academic studies he had obtained an Msc in Biology from Tehran university in 1987 and since then he had been teaching microbiology as a member of staff in Ahvaz university in the south east of Iran. His reading comprehension TOFEL score after it had been converted was 50 which showed him to be a proficient foreign language reader.

The second skilled subject, SI2, taking part in the think-aloud study was a male Ph.D. student of Botany studying in the Botany department of Paisley University. He arrived in Scotland in 1992 to do his postgraduate studies after getting his Msc in Horticulture from T. Modarres University, Tehran. At the time of the experiment he was writing his thesis and in spite of lack of time to submit his thesis he warmly welcomed the idea of taking part in the experiment. His performance on the TOEFL (he scored 52) showed that he was well above the mean of 50 thus was ranked as proficient in reading in English. As his protocols show he was ranked as a cooperative informant since he tried to spell out as many thoughts as he could.

The third subject, SI3, participating in this study was a male postgraduate student of Botany studying in the Botany Department of Glasgow University. He got his Msc in Botany from Tehran University in 1990. Since his arrival in Glasgow in 1992, he has been experimenting with his project and at the time

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of the think-aloud session he was arranging for a scientific trip to Holland for three months. The experiment was done in his flat where he felt more relaxed. A week after the experiment in order to have his language proficiency file, I asked him to take the TOEFL reading comprehension test. He obtained 50 on the test. Apart from his TOEFL score, he appeared uncooperative in the experiment viz. his verbalization shows his avoidance of spelling out as many thought processes as he could.

SI4 is a male Ph.D. student of Biogenetics of the Glasgow University. A father of two, he obtained his master's degree in Biology from Tehran University in 1988 and came to Britain in 1993 to do his higher academic education. Unlike his wife, also a Ph.D. student, who managed to get a scholarship from the Iranian ministry of culture and higher education, he himself is financing his studies. Upon hearing about the experiment, he announced his readiness and the experiment was done in his room in his department. Generally, he is polite and a bit hasty. After the experiment he told me that he was anxious at the beginning of the experiment and that he gradually got relaxed. In order to have his English proficiency file, I asked him to take the reading TOEFL test a fortnight after the think-aloud session. He got 50 in the test, thus was ranked as an advanced foreign language reader



of English. However, as his think-aloud protocols show he was not as cooperative as SI1 and SI2 were.

SI5 is a male postgraduate student of Microbiology at Glasgow University. He obtained his master's degree in Microbiology from T.Modarres University, Tehran in 1989 and came to Scotland in 1991. At the time of this experiment he was preparing himself for his viva voci session and would successfully pass the exam a month after taking part in this experiment. A father of three, he has a calm and reliable character with a sense of self-confidence which can easily be found in his social behavior and manner. Two weeks after the think-aloud experiment which was conducted in his flat in Glasgow, he was asked to take the TEOFL reading comprehension sample test. His score was quite satisfactory viz. he obtained 58 which is in fact higher than the national mean score of the TOEFL referred to earlier.

SI6 is a male postgraduate Ph.D. student studying Biogenetics in the Institute of Acquaculture, Stirling University. He arrived in Scotland in 1994 and since then he has been experimenting with fish. He is an intelligent, diligent and gifted person and was able to enter the Ph.D. course without having a Master's degree. His TOEFL score is also quite satisfactory. He obtained 53 which is well above the national mean score. When I talked to him about the think-

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aloud experiment he immediately accepted the request. The experiment was conducted in his room in his department a week after my proposal. His performance on the task was absolutely cooperative, viz. he tried to do his best in verbalizing his thought processes while reading the text.

SI7 was a male postgraduate student doing his Ph.D. in Biogenetics in the Institute of Aquaculture at Stirling University. He arrived in Sterling in 1994 and after sitting in some English classes he started his studies. In spite of lot of experimental work, he accepted to cooperate with the experiment. The experiment was done in one of the lecture rooms in the Institute of Aquaculture. The session lasted for one and a half hour. After a 15 minutes time break I gave him the TOEFL reading comprehension sample test and he did it within the required time. His score on the TOEFL test was 51 thus was ranked as proficient foreign language reader of English.

A Ph.D. male student of Biology at Glasgow University, SI8 got his Master's degree in Botany from T.Modarres University, Tehran in 1987. Since then up to 1993 when he for the first time arrived in the United Kingdom, he had been working as a lecturer in Mazandaran University located in the northern part of Iran. At the time of the experiment he was still continuing his laboratory experiments. The experiment was conducted in his own flat and took one and

a half hour. A short time after the experiment he was given the TOEFL reading comprehension test. He obtained 50.

As to selection procedure of the subjects, no real statistical attempt was made to employ random selection procedure inasmuch as not many subjects were available to allow the present researcher to select from among them.

Total subjects	Field (PhD)				Previous Academic Record (MSc.)			
	Mic	Bot	Biog	Bio	Bio	Horti	Bot	Mic
8	2	2	3	1	4	1	2	1

Table 4.2. Distribution of skilled subjects in terms of current field and their previous academic records. The above abbreviations represent Mic for Microbiology, Bot for Botany, Biog for Biogenetics, Bio for Biology, Horti for Horticulture.

#### 4.4. Selecting Appropriate Reading Materials

An important phase of almost any reading research and particularly research on second language strategy identification is selecting appropriate reading materials. This resides in the fact that by selecting proper experimental materials an investigator can account reasonably for the data. An important question which may be raised in this regard is determining the criteria used in the selection. Such criteria may involve readability, length, and topic accessibility. These will be discussed below.



#### 4.4.1. Readability

The notion of readability is the extent to which a text appears to be appropriate for the population under study. It originates from the notion of the difficulty level of a text, The primary concern of text readability studies is the focus on those particular features of text which cause difficulty to readers. This view takes the reader as the main consumer of text information and tries to analyse the text in terms of its linguistic features (Klare, 1974).

To determine text readability two main approaches have been employed in the literature: 1) measuring readability through linguistically-driven formulae such as the Fog index and 2) a holistic approach in which selection is based on investigator's judgement. Readability in the first version corresponds to the layman's view of text difficulty, that simple English is written in short easy sentences with not too many long words. Readability studies of this sort are challenged, however, on the grounds that such studies 'result in *indices* of difficulty and do not claim to be indicative of difficulty' (Alderson and Urquhart, 1984; P:xxii).

Other failures are attributed to readability formulae which include the following: 1) they are often used as sole measures of reading level and result in serious mismatches of reader to text (Addison, 1983), 2) text organisation

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(Urquhart, 1984) and features such as cohesion, subject content, content structure and physical layout are rarely, if ever, taken into consideration (Dakuta, 1980 in Addison, op.cit.), 3) levels of abstraction and conceptual difficulties of texts (Alderson and Urquhart, op.cit.) are not considered in readability formulae, 4) the variety of reading abilities that students bring to understanding a text in the classroom might make the selection of reading materials based on the readability formulae alone a moot issue (Addison, op.cit.). 5) They ignore the reader and reader variables such as background knowledge, experiences and beliefs and the interactive nature of the reading process- the interaction of the reader with the text<sup>2</sup> (Carrell, 1987). Indeed, many studies have shown the crucial nature of the interactions between a text and the reader's content schemata (Steffenson and Joag-dev, 1984; Carrell, 1983; Alderson and Urquhart, 1985), and the interaction between a text's rhetorical organisation and the reader's formal schemata (Urquhart, op.cit.).

Studies of this sort have so far been quite illuminating with regard to the readability index and the cause of text difficulty, but there still exists a demand

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<sup>2</sup> Silberstein (1987 in Carrell, op.cit.) has called attention to an approach to literary criticism which also explores the mysteries of textual interaction- namely reader response theory. According to this theory, meaning is not contained in the text, but is derived from an interaction between the content and structure of the author's message and the experience and prior knowledge of the reader; that readers comprehend differently because every reader is culturally and individually unique; and that examining reader's responses to text is more valid than establishing one CORRECT interpretation of text meaning.

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for a comprehensive formula in readability research to account for issues such as the conceptual complexity of text and the other variables which need careful consideration when estimating text difficulty.

A second trend in determining the difficulty level of the text in a 'mentalistic approach' is through the professional judgement of people engaged in managing a course (Cohen, 1984). Teachers of the course for which a text is going to be selected, and researchers familiar with the needs of the target population all may help decide on selecting an appropriate text which is in harmony with the subjects' level of comprehension and need. However, to decrease the subjective judgement factor and add to the general acceptability of the decisions, some considerations can be taken as fundamental. For example providing a list of factors important in selecting a text, and asking more than one person familiar with the target population for which the text is going to be selected in order to add to the objectivity of the selection may contribute to the face validity of the decision. At this stage, the team may wish to consult with an informant who is an expert in that field and a native of the language in which the text is written. This approach was taken by Selinker (1979) in an EFL study focusing on a genetic text and also by Huckin and Olsen (1984).



As regards the present study, no attempt has been made to employ linguistically-driven readability formulae such as the Fog index referred to in Urquhart (op.cit.). Instead an impressionistic judgement *per se*, has been employed. However, to be on the safe side, two more instructors teaching English to the novice subjects were asked to give their views about the difficulty level of the texts chosen for the population under the study. They both agreed on the suitability of the selected texts. They were also given a list of questions based on Carrell's (1987) recommendations in which parameters such as contextual support, information density, and conceptual and syntactic complexity are given consideration. This list of questions is given in *Appendix A*.

Other important factors were observed as crucial in selecting the texts for the target population.

#### **4.4.2. Length**

In selecting content, length of chunks to be processed have been considered to play a role in text difficulty. In a think-aloud task, as Rankin (op.cit.) argues, a passage must be long enough to allow the subject to become involved in the task 'but no so long that they become fatigued by the demands of thinking

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aloud for extended periods' (P:123). He suggests that a range of 300 to 1000 words length seems to be appropriate under most conditions<sup>3</sup>.

Considering the cognitive load that a long passage may require the novice readers in this study to devote to text processing and the verbal report task, two passages of 574 and 414 words were selected for the novice subjects.

As regards the skilled subjects, it was hypothesised that skilled readers might not have the same difficulty in text processing as the novice readers were assumed to have as far as the length is concerned, but some thought was given to time requirement of the think aloud task. Subjects were expected to think aloud within an ideally estimated time of two to three hours. The hypothesis was that any extension of time above this would make the task boring to

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<sup>3</sup> However, two important factors are given consideration in regard to text length. One is that length by itself is not as influential in increasing text difficulty as when it interacts with other cognitive factors such as the conceptual complexity of the text viz. 'the degree to which concepts, notions, ideas, arguments and relationships between entities are difficult to understand' (McLean, 1992; P:2). Therefore, a short text with a high level of conceptual complexity may be more difficult to be processed than a lengthy passage of low conceptual complexity. This means that in any act of passage selection, one should take into account the conceptual level of text complexity, otherwise, relying on the length itself may result in inappropriate text selection and eventually unjustified decisions which may be made from the data. A second important issue regarding length is the characteristics of the research population (Rankin, op.cit.). It is considered that the less proficient language readers should be asked to read shorter passages than more proficient language readers. The reason is the cognitive load which a lengthier passage may demand the less proficient readers to devote to text processing. The relevance of this becomes clear particularly in think aloud studies which require subjects to do two things at the same time mainly, reading the text and reporting the processes involved.

subjects who might decide to do the task quickly to get rid of it<sup>4</sup>. The text contains 1961 words.

Bearing these considerations in mind, it was decided to do two things as far as the length of the text for the skilled subjects are concerned: 1) to choose the text to be do-able, so to speak, that is, to avoid selecting an extremely difficult text which may cause over-loading of the subjects' processing system and possibly its complete breakdown, a state which is called 'trashing' by Britton and his colleagues (op.cit.); 2) to adopt a moderate view towards the length of the text to make it possible for the skilled reader to do the task within the time constraints proposed for the think aloud session.

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<sup>4</sup> Any decision on length could not be viewed in separation from other factors such as conceptual complexity of the text and the degree to which a text might seem to be unfamiliar to the expert reader. Think aloud experiences with expert readers (Ericson and Simon, 1984) have indicated that skilled readers do not report reading processes that are automated (c.f., Shiffrin and Schneider's, 1977 dichotomy between automatic and controlled processing). This means that protocols obtained from skilled readers reporting on familiar texts indicate that such readers do not report on their text processing and automatically pass over them due to their familiarity with such texts. This has been an embarrassing variable for introspective researchers who have because of such automatic processing been deprived from getting more insight into skilled reading strategies. Obviously, under such circumstances length of the chunks may play a minor role in facilitating verbalisation of skilled reading. However, suggestions have been made to 'de-automate' the reading processes with skilled readers in order to make those processes more reportable (Johnston and Afflerbach, op.cit.). Such de-automatization is reported to become possible if the skilled readers are given unfamiliar or otherwise difficult texts, 'as subjects become 'novices' in relation to content of the text while maintaining their processing expertise' (Johnston and Afflerbach, op.cit.; P:214). Therefore, if the text chosen for the skilled reader is to be unfamiliar or difficult, then length of the text may become a determining factor. A difficult and lengthier text might lead to frustration on the part of the reader and may possibly be counter-productive to the think aloud task.



### **4.4.3. Topic Accessibility**

The role of background knowledge has long been confirmed to facilitate reading comprehension in both first (Rumelhart, 1977) as well as second language readers (Carrell, 1983; Alderson and Urquhart, 1985). It has been recommended in the literature that an entirely unfamiliar text is to be avoided for novice second language readers.

Given the novice subjects, it might be thought that the texts which best serve research goals of the think aloud kind is the use of passages from subjects' current classroom reading materials (Rankin, *op.cit.*). Nevertheless, due to shortcomings of the current textbooks being used in their classroom, I decided not to select such materials, but instead, texts which were similar to the subjects' reading materials in terms of topic accessibility. Also, to avoid last-minute setbacks the chosen texts were pilot studied. An account of the pilot study is reported in chapter 2.

Regarding the text chosen for the skilled subjects, a text from the biology field was selected with the help of one of subjects' supervisors who commented on the text as suitable. The text was piloted with one Ph.D. subject whose protocol data showed that the text was appropriate for the experiment purpose.

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#### 4.4.4. Texts Used In The Experiments

The following texts served as the experimental texts given to the subjects in this study. T1 and T2 are excerpts taken from Pearson's (1978) *English in Focus: Biological Science* and were presented to the novice readers, while T3 is a paper taken from *Systematic Biology Journal* (1993) and was given to the skilled readers.

##### Text 1. (T1)

### The Differences Between Plants and Animals

Plants characteristically synthesize complex organic substances from simple inorganic raw materials<sup>1</sup>. In green plants the energy for this process is sunlight<sup>2</sup>. The plants can use this energy because they possess the green pigment chlorophyll<sup>3</sup>. Photosynthesis, or 'light-synthesis', is a 'self-feeding', or autotrophic, process<sup>4</sup>.

Animals, on the other hand, must obtain complex organic substances by eating plants or other animals<sup>5</sup>. The reason for this is that they lack chlorophyll<sup>6</sup>. Among these 'other-feeders', or heterotrophs, we distinguish between 'solid-feeders', or phagotrophs, and 'liquid-feeders', or osmotrophs<sup>7</sup>. Whereas phagotrophic organisms take in solid and often living food, osmotrophic ones absorb or suck up liquid food<sup>8</sup>. This is usually from dead and rotting organisms<sup>9</sup>.

Plants and animals, then, have characteristically different feeding methods<sup>10</sup>. However, we cannot *define* plants as autotrophs and animals as heterotrophs<sup>11</sup>. The reason for this is that many plants lack chlorophyll and feed heterotrophically, and some animals possess it and feed autotrophically<sup>12</sup>. The problem is well-illustrated by the various species of protozoans that are grouped together in the genus *Euglena*<sup>13</sup>.

Most species of *Euglena* possess plastid with chlorophyll inside (i.e. chloroplast) and therefore they can photosynthesize<sup>14</sup>. However, all the green species are unable to

synthesize at least one organic substance that they need, and they must obtain these substances osmotrophically<sup>15</sup>. They are therefore partly autotrophic and partly heterotrophic<sup>16</sup>. The colourless species must obviously be fully heterotrophic<sup>17</sup>.

### Text 2. (T2)

## Reproduction

When an organism stops reproducing, its own survival becomes unimportant<sup>1</sup>. In fact, among the larger and more complex plants and animals, death is the necessary consequence of ceasing to reproduce; when the individual begins to grow old, the process cannot be stopped<sup>2</sup>. It is possible that all organisms are like this, although most individuals do not die of old age but through accidents or disease, or because they are killed by other organisms<sup>3</sup>.

How long an individual survives depends partly on chance and partly on whether it has any advantage over other individuals<sup>4</sup>. For example, when food is short, the better hunter, or the faster eater, or the larger individual may survive when others cannot<sup>5</sup>. Some individuals, in other words, have characteristics that have a survival value and we say that they are better adapted to their environment than the others<sup>6</sup>. Obviously, the individuals which are better adapted have a higher chance of living long enough to reproduce<sup>7</sup>. Less well-adapted individuals are more likely to meet death before reaching maturity<sup>8</sup>.

In both sexual and asexual reproductive processes, the first stage of the new generation is always a part of the preceding generation<sup>9</sup>. The most important feature of this physical continuity between generations is the passing on of chromosomes<sup>10</sup>. Individuals produced asexually always have chromosomes that are identical to those of their parents, but sexually produced offspring necessarily possess a new combination of chromosomes<sup>11</sup>. In addition, individual chromosomes are often altered during meiosis due to an exchange of material between chromosomes<sup>12</sup>. Thus, sexual reproduction ensures that the members of a species are all more or less different<sup>13</sup>.



The importance of variation between individuals of the same species means, in the short term, that some are better adapted than others<sup>14</sup>. But the history of the world is a story of change and in a changing environment variation may enable a species to survive<sup>15</sup>. However, if the individuals which survive and reproduce have new characteristics, then after many generations the individuals may look very different from their ancestors<sup>16</sup>. Evolutionary theory tries to explain how and why this happens<sup>17</sup>.

### Text 3. (T3)

## Model Organisms in Evolutionary Studies

Mendel used peas<sup>1</sup>. Morgan used *Drosophila*<sup>2</sup>. Delbruck used T4 phages<sup>3</sup>. The idea was to learn about the general by studying the particular, to use a specific organism as a model for all others<sup>4</sup>. The approach has been unquestionably powerful and successful<sup>5</sup>. Laboratory-based studies of molecular and cellular biology have come to dominate the field of biology, using a handful of familiar laboratory models: *Escherichia coli*, yeast, maize, *Arabidopsis* (a cabbage relative), *Drosophila*, *Caenorhabditis* (nematode), *Xenopus*, and mouse<sup>6</sup>. These are commonly thought of as *the* model organisms<sup>7</sup>. The result has been a very large community of scientists using a very small group of organisms to answer questions fundamental to much of biology<sup>8</sup>.

In systematics, by contrast, a relatively small group of scientists studies a very large number of organisms<sup>9</sup>. The importance of model organisms to systematists, and of systematists to laboratory biologists who rely on model organisms as research tools, has never really been explored<sup>10</sup>. Yet it seems clear that there should be much common ground for these two disparate groups of biologists<sup>11</sup>. Laboratory biologists understand mechanisms, potentially explaining how characters evolve, the mechanistic basis of convergence, and a host of other issues that lie at the heart of controversies in character independence, models of phylogeny reconstruction, and homology<sup>12</sup>. Systematists understand relationships and history; they can provide the historical framework necessary to generalize the results from particular model systems to an appropriately broad or narrow array of organisms<sup>13</sup>.

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Last year, we asked a number of systematists to participate in a symposium exploring the relationship between systematic inferences and experimental bench work on their favorite model organism<sup>14</sup>. We chose a set of organisms that spans a broad phylogenetic and biological spectrum and contacted colleagues who are in touch with both groups of researchers<sup>15</sup>. Eight organisms were discussed, and six papers (dealing with *Zea*, fungi, *Drosophila*, *Xenopus*, axolotl, and *Mus*) in this issue of *Systematic Biology* comprise the written results of this effort<sup>16</sup>. In these papers, we asked each author to discuss a series of topics on each organism<sup>17</sup>. What is known of its phylogenetic relationships, both at a broad and restricted level<sup>18</sup>? Why is the organism a valuable model in the laboratory<sup>19</sup>? How can the detailed, mechanistic information on that organism be used to further systematic research, and how can the phylogenetic position of the organism be used to guide comparative laboratory work<sup>20</sup>?

The various papers explore these ideas in greater or lesser depth, depending on what is known of the organism and on the orientation of the individual systematists<sup>21</sup>. In most cases, the systematics has lagged far behind the bench work; for several species (e.g. *Arabidopsis thaliana*), the phylogeny is so rudimentary that no clear direction for comparative studies can be provided at this time<sup>22</sup>. For others (notably the vertebrates), the phylogeny appears to be somewhat better understood<sup>23</sup>. In all cases, the need for broad interactions among research groups is a missing ingredient that should be added<sup>24</sup>.

In the remainder of this paper, we briefly summarize some of our own ideas on why systematists and laboratory biologists can and should help each other in the quest for general patterns and mechanisms in biology<sup>25</sup>. In so doing, our hope is that we may at least partially convince the scientific community that the systematics of any model organism, be it wheat, zebrafish, or *homo*, can provide unique insights into the evolutionary mechanisms that drive diversification and cladogenesis<sup>26</sup>. This interface may actually resolve some long-standing debates in systematics and provide direction for laboratory biologists that will ultimately benefit both groups<sup>27</sup>.

The argument for the model organism approach is a fundamentally practical one<sup>28</sup>. We have neither the time nor the resources to study every species in detail, and for many questions it would be a waste to do so<sup>29</sup>. If the goal of most work in biology is a mechanistic understanding of how organisms and their constituent parts work, then

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almost any organism will do as a research tool<sup>30</sup>. The point is to understand a few organisms very well and apply those results to an appropriate sector of the biological world<sup>31</sup>.

How are organisms chosen to become model systems<sup>32</sup>? Many were chosen initially because they were both accessible and variable<sup>33</sup>. Darwin began *The Origin of Species* with a discussion of artificial selection in pigeons—a good model because there are plenty of pigeons in England and the strains mimicked naturally occurring variation<sup>34</sup>. *Drosophila* species are easy to find and to collect wherever there is rotting fruit<sup>35</sup>. Most plant models are either crops for which abundant seed is available, or weeds<sup>36</sup>. Mice and rats have always been plentiful around human habitations<sup>37</sup>.

Other models, especially those developed more recently, have been chosen for their tractability in laboratory work<sup>38</sup>. *Arabidopsis* is easy to breed and grow in the lab<sup>39</sup>. *Xenopus* is handy because it has large visible eggs, breeds often, and is easy to maintain<sup>40</sup>. T4 bacteriophage and its host *E. Coli* remain important for molecular biology because vast populations can be easily grown and screened and their biology was (naively, as it now appears) thought to be simpler than that of multicellular organisms<sup>41</sup>.

Although accessibility and tractability are important, the ultimate rationale for using model organisms depends on the ability to generalize to other organisms<sup>42</sup>. Much laboratory work is justified on the basis of providing insights that will have medical or agronomic applications<sup>43</sup>. This applicability depends on the extent to which the model really function as models, which can only be estimated in a comparative context<sup>44</sup>. A colleague in a department of cellular and developmental biology described the mission of his department as searching for commonalties (W. Gilbert, pers.comm.)<sup>45</sup>. The recognition of commonalties comes from comparative work<sup>46</sup>. The laboratory models can be compared—a comparison across kingdoms—and similarities taken as fundamental aspects of life<sup>47</sup>. This approach is obviously powerful; it is the source of most of our understanding of genetic structure and function and much of what we know about proteins and cell biology in general<sup>48</sup>. It is also higher level systematics<sup>49</sup>. The commonalties at this level are synapomorphies of life, or at least of kingdoms<sup>50</sup>.



The limitations of this approach become obvious when evaluating the differences among model systems<sup>51</sup>. Characters evolve, leading to shared similarities that vary across a nearly infinite number of hierarchical levels<sup>52</sup>. Certain characteristics, such as nucleic acids for encoding genetic information, are constant across life, whereas others are restricted to a single species, population, or individual<sup>53</sup>. Herein lies the dilemma in applying the results from model organisms: one needs to understand the distribution of individual characters to generalize beyond a specific study system<sup>54</sup>. Thus, the clawed frog, *Xenopus laevis*, has become one of the premier models in vertebrate developmental biology, and studies of the structure of the neural crest and the nature of fertilization rely on generalizations based on this single amphibian<sup>55</sup>. However, from a phylogenetic and morphological perspective, *Xenopus* is a member of a basal, extremely modified family of frogs that are unique and bizarre in most aspects of their biology<sup>56</sup>. Is *Xenopus* a generalizable model for all vertebrates, or is it an anomalous taxon that is not even a very good example of a normal frog<sup>57</sup>? The answer depends on the character<sup>58</sup>. For neural crest migration, *Xenopus* is a fine model system<sup>59</sup>. For the biomechanics of feeding, it is a member of a uniquely derived group of aquatic tongueless frogs that serve as a model for very little<sup>60</sup>.

The power of model organisms thus comes from the enormous amount of detailed, specific data accumulated by a large community of scientists<sup>61</sup>. The weakness comes from the relative paucity of comparative data, combined with the lack of a good phylogenetic framework to guide the assembly of those data<sup>62</sup>. Comparative biologists in general and systematists in particular have yet to avail themselves fully of the trove of information on model organisms<sup>63</sup>. Moreover, the laboratory-based scientists have generally not exploited the power of phylogenetic data for framing comparative questions, in part because of a difference in vocabulary and approach between work on a single species and work on a large group of organisms<sup>64</sup>. The difference is between conducting experiments and analyzing biological history (O'Hara, 1988); the nature of the questions is different, as is the nature of the evidence<sup>65</sup>. An experimentalist can ask a precise question and then design a method to test it<sup>66</sup>. Multiple experiments can give answers that are (largely) unambiguous<sup>67</sup>. The phylogeneticist, however, analyzes pattern<sup>68</sup>. The 'experiment' was a cladogenetic event that happened in the distant past and was not replicated<sup>69</sup>. The challenge is to discern what might have happened, the results of such studies are more likely to eliminate possibilities than to provide definitive answers<sup>70</sup>. Hypotheses emerge gradually as the result of accumulated small insights rather than



definitive experiments<sup>71</sup>. Because of such differences in approach, experimental scientists and phylogeneticists have tended not to understand the underlying questions of each other's disciplines, much less to delve deeply into the details of the literature<sup>72</sup>.

What, then, are the most important ways in which laboratory and phylogenetic research programs can and should communicate<sup>73</sup>? We see two important interfaces, or linkages, between the two research programs<sup>74</sup>. The first link is the use of extensive data from model organisms to understand character evolution<sup>75</sup>. It is now possible to identify phenotypes that mark cladogenetic events and to find similar phenotypes described in detail at the cellular and molecular level in model organisms<sup>76</sup>. Therefore, it is now possible to describe character transformations at a mechanistic level<sup>77</sup>. Many of the papers in this symposium give examples of particular genes and gene systems that are of potential interest<sup>78</sup>. Other examples have been published elsewhere<sup>79</sup>. A set of genes controlling the identity of flower parts has been cloned from *Arabidopsis* (coen and Meyerowitz, 1991)<sup>80</sup>. Putative orthologues having a similar effect have been identified in snapdragon (*Antirrhinum*)(Coen and Meyerowitz, 1991) and in maize (see Kellogg and Birchler, 1993 [this issue])<sup>81</sup>. The wide distribution of these genes suggest that they may affect the identity of floral organs in all angiosperms; they may thus provide a new tool with which to address the origin of the angiosperm flower from its gymnospermous ancestors (Doyle, 1993)<sup>82</sup>.

The second link between these two disciplines is the use of phylogenies to evaluate the generality of model organisms<sup>83</sup>. How common are the commonalities<sup>84</sup>? Systematics is based on the premise that the more distantly related organisms are, the less they have in common<sup>85</sup>. Thus, when the one-organism-per-kingdom approach uncovers difference, it becomes necessary to discern at what level the difference lie<sup>86</sup>. Taylor et al. (1993 [this issue]) described cases where a difference between *Drosophila* and *Sacchromyces* (e.g. presence or absence of introns) might naively be interpreted as differences between animals and fungi<sup>87</sup>. However, this interpretation places the change at a specific point in evolutionary time; to describe the difference as a kingdom-level difference makes a very precise and unsupported claim about the distribution of the character<sup>88</sup>. However, study of another ascomycete *Schizosaccharomyces*, shows that the difference must have appeared somewhere in the lineage leading to yeast itself; this fission yeast has the 'animal' character state

(e.g. introns present rather than absent as in *Saccharomyces*)<sup>89</sup>. Accurate placement of a character state change ultimately requires extensive sampling<sup>90</sup>.

Establishing the generality of model species will necessarily involve collaboration between systematists and experimentalist<sup>91</sup>. The decision of which taxa and characters to compare will rest heavily with the systematist, whereas the nature of the experiments will be the purview of the scientist grounded in the model species<sup>92</sup>. The door is now open for developing a new synthesis of genetics, development, and systematics<sup>93</sup>. The challenge is to assemble all three sorts of data in a single system so that the different approaches can be mutually reinforcing<sup>94</sup>. Model species can provide the vehicle for such a synthesis and allow development of model systems for evolutionary studies<sup>95</sup>.

## **4.5. Experimental Procedures**

### ***4.5.1. Planning The Sessions***

As Cohen (1984) suggests, the first methodological decision concerns the setting for the study. Due to the nature of this study which seeks to elicit strategy use among individual second language readers of both novice and skilled levels, I decided to arrange meetings with the novice subjects in a private place and outside of the classroom. A clean and newly-decorated silent room in the basement of the faculty of Humanities of Mashhad University, Iran, was chosen for the experiment. Both subject and the present researcher sat at the opposite sides of the table on which there was a sample of reading comprehension TOEFL tests, a folder containing experimental materials and some white sheets used for taking notes about subjects' extra-verbal moves and



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strategies such as facial gestures which could not be recorded via tape recorder. There was also a tape recorder used to record protocol data.

Each subject on arrival was warmly welcomed and ten minutes at the beginning of each session was devoted to chatting about different issues in order for the subject to feel relaxed and to establish rapport. This had a tremendous effect on the subjects who were probably seeing themselves in an odd situation. It was observed that some subjects who seemed to be nervous on their arrival later on relaxed. Also, to help further in relaxing the subjects between the two verbal reports (that is, verbalization on two different texts given to the subjects for the experiment) subjects were served with refreshments.

Regarding the setting for the skilled readers, they preferred to conduct the experiment in their homes, where they reasoned they felt more relaxed. Each setting was generally silent and the subjects' reaction to the task from the beginning up to the end confirmed that they were quite comfortable in this setting. The experimental facilities were the same as those used for the novice subject.

#### *4.5.2. Pre-experimental Training*

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For most subjects the verbal reporting task is something new and novel and requires attention to be paid to both processing and reporting of the task (Afflerbach and Johnston, op.cit.). The rationale behind familiarising or training subjects before the main task is that the subjects would be more prepared, so to speak, to report their thought processes than when they are not. In other words, this preparation is hoped to lead to producing more explicit verbal reports which in turn may lead to better identification and classification of the processes. It will also result in fewer inferences on the part of the researcher and the higher reliability of the data.

To familiarise subject-informants with the task, investigators have employed different methods and procedures. These range from pre-experimental practice sessions (Hosenfeld, op.cit.; Kavale and Schreiner, 1979; Sarig, op.cit.) in which subjects are shown instances of thinking aloud by the experimenter or an assistant, demonstration tapes (Bridge and Winograd, 1982) wherein the same instruction is presented but through tape, and pre-study introspection (Johnston and Afflerbach, op.cit.) in which subjects are asked to think about the processes they use while reading. In this latter case subjects do not receive any explicit training as to how to think-aloud, but instead are given awareness about what they are required to do prior to the actual reading experiment.

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This study employed the current method of pre-experimental training. Each subject before getting into the main task was instructed as to how to handle the task and what was required of them. I thought aloud the first three sentences of a sample text selected for the pre-experimental purpose and explained that what I was interested in was the subject's report of whatever comes to their mind when reading the text (that is, level 1 and 2 verbalization). After these initial explanations about the task each subject received a sample passage and was asked to verbalise his\her thought processes.

Some subjects due to lack of practice sometimes forgot to report while reading the passage. Such lack of report was noticed when they kept silent for more than 30 seconds by tracking their forward and backward eye movements and occasional pauses which indicated that they were processing the passage. This processing-report interval was tended to support Ericson and Simon (1993) and White's (1980) position on the importance of minimising the processing-reporting time gap as a means of maximising completeness of verbal reports of cognitive activity. To attract their attention to the verbalization side of this preliminary task, they received prompts such as *remember I am interested in what you are doing when you are reading, what you are reading or what are you doing now?* These prompts helped them to perform better on the actual experimental task.



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### 4.5.3. The Main Task

With regard to the novice readers, each subjects received the sample TOEFL reading comprehension section together with an answer sheet prior to the main task. To familiarize subjects with the introductory directions of how to do the test and how much time they would need to do the test, a brief explanation based on the directions given at the beginning of the reading section was presented to them. The overall time devoted to doing the test was forty five minutes based on the standard testing time proposed by the TOEFL organisation.

As a relief from the mental activity spent over the reading TOEFL test and to prepare subjects for the main task of thinking aloud, each subject was given a break of 15 minutes during which they were given tea, coffee, etc. During this time they tended to ask questions about such matters as their test-taking strategies and their own views on how to get better grades. These casual exchanges appeared to affect their attitude positively towards the experiment atmosphere.

As was stated earlier, in any concurrent verbal report investigation, subjects are required to do two things at the same time, mainly the experimental task (for example, reading a text) and the verbalization task. It is argued in the

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literature that the characteristics of the task may affect the nature of overall strategies employed by the subjects and the 'ecological validity' of the report data (Afflerbach and Johnston, op.cit.). For instance, requiring subjects to read in order to find answers for multiple choice questions (cf. Far, et al. 1990) might result in different strategy use and elicitation than when asking subjects to summarise texts (Brown and Day, 1983 in Afflerbach and Johnston, op.cit.) or answer comprehension questions (Kavale and Schreiner, op.cit.).

In this study, none of the above questions were asked from the subjects. The main requirements of the task were reading for general comprehension or reading for meaning. After having been tested on a sample reading comprehension TOEFL test, both groups of subjects were instructed once more about the purpose of the research and that I was interested in what they were doing while reading.

#### **4.5.4. Using Probes**

The use of probes or statements which are used to remind the subjects to report thought processes during think-aloud experiments is an important methodological concern in introspection studies. To avoid the use of probes some researchers like Afflerbach and Johnston, as stated above, recommend the use of practice sessions to familiarize subject informants more with the

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think-aloud task. Accordingly, such sessions are to continue until subjects generate evidence showing that they are paying enough attention to both the procedure and the reporting of the procedure (Afflerbach and Johnston, *op.cit.*). Nevertheless, such sessions may present practical problems to the researcher. Firstly, due to the subjects' different capabilities in both reading and reporting, it may require the researcher to devote a considerable amount of time to those who are less capable in performing the two tasks in fewer sessions than those who show better performance. This, regardless of the time which may be imposed on the researcher, might result in the subjects' withdrawal from continuing the practice sessions which may seem to them boring and tiresome.

Secondly, such subjects usually do not participate voluntarily in such prolonged sessions without being paid (*cf.*, Block, *op.cit.*). This may provide a researcher with extra costs which are not usually met by the grants given to him/her. Thirdly, subjects may bring certain habits (for instance, using specific reading strategies) acquired through such practice sessions to the main task which may bias the actual data collection procedure. Finally, Afflerbach and Johnston do not explicitly define what is really meant by 'sufficient evidence' showing that subjects are paying attention both to the processes and the task.



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However, what seems to be clear is that using probes should be fostered in think-aloud investigations.

Indeed, due to practical problems in Afflerbach and Johnston's proposal, no attempt to the present researcher's best knowledge has so far been made by the reading introspectionists to employ this procedure. Instead, other techniques have been utilized: using dots at certain portions of the text (Olshavsky, 1976-1977; Block, *op.cit.*) viz. after each sentence, or after each paragraph which reminds the reader to report on the process; leaving subjects to verbalize at will but with occasional probing (Hosenfeld, 1984); asking subjects to report whenever a pause occurs in their reading processes (Cavalcanti, 1983). Of these techniques the first one is criticized on the grounds that such predetermined dots at particular junctures may result in the complete loss of those thoughts that may come in between (Rankin, *op.cit.*). And sometimes such dots are ignored by a subject absorbed in reading. Rankin reports some subjects' dissatisfaction with these dots as interfering with their reading.

As regards asking the subjects to report their mind processes (or using probes during think aloud sessions), a compromise between Hosenfeld's suggestion and that of Cavalcanti was adopted in this study. That is, subjects were asked to report at the end of the sentence and whenever a pause occurred in their

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flows of reading. But due to the novelty of the task and subjects' occasional absorption in the task leading to an absence of report on process, it was felt necessary to remind them to report on the processes if they kept silent for more than forty seconds. Probes as recommended by the literature were of 'undirected' (Garner, 1982) kinds such as 'remember we are interested in what you are doing' and 'what are you doing now'. The probes were of level 1 verbalization type which required the readers to directly articulate information stored in their STM. Therefore, attempts were made to avoid asking questions pertaining to level 2 and level 3 verbalization (see section 3.1.2.2.).

#### ***4.5.5. Retrospection As A Multiple Indicator Of The Task***

Cognitive processes are not directly observable and need other sources to help the investigator in inferring the processes. For this reason, there has been a growing concern in recent think-aloud studies of reading comprehension about assessment of consistency of the think-aloud data (Ericson and Simon, 1984, 1993; Rankin, op.cit.). Afflerbach and Johnston, for example, complain that most verbal report researchers have not employed multiple indications of the primary experimental task, such as retrospective data and eye movement data to be compared to verbal report data. Obviously, such additional safeguards can ease inference of reading processes and provide the researcher with different vantage points on the inference task.

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Suggestions of using multiple indicators have been diverse from using observers (Garner, op.cit.) to using videotapes (Afflerbach and Johnston, op.cit.). Apart from the psychological effects which the use of video may have on the subjects when they find that they are being filmed, it appears to be not helpful since the process of reading takes place in the mind of the reader (Rankin, op.cit.), hence not observable when visually taped.

Regarding which methods are to be used and selected in a multi-method approach, Cohen and Manion (1980) argue:

'-we take it as axiomatic that any one method can be efficient, less efficient or inefficient depending on the kind of information desired and the context of research. Where a researcher seeks information from which his inferences can be generalized to wider populations, methods yielding statistical data will be most efficient. Where he looks for information representing a personal or phenomenological perspective, or *process* {my italic} rather than product, accounts or interviews will meet his needs more successfully. If he wants to integrate objective and subjective perspectives, he will use contrasting methods. The first task, therefore, will be to decide *what kinds* of information the researcher wants and, further, what he is to do with it' (P:216).

Accordingly, there is a direct relationship between the selection of method and the context of the research. Bearing the fact in mind that the main purpose of this study is an investigation of reading process and strategy, the best option would be the use of a method which yields non-quantifiable data such as eye movement measures. Use of other quantifiable methods such as questionnaire



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can also be possible but as Cohen and Manion suggest, one main problem is how to combine the methods. As they assert, this is a question for which no simple directive can be proposed. A further problem arising from the use of quantifiable method data to be used with qualitative data presents itself in the form of inconsistent results. Although, as Cohen and Manion suggest, it is always possible to relate incongruent data in some way or another, the use of such data depends on the researcher's original objectives in doing his/her study.

Based on the objectives of this study, eye movement measures could have been the best option in providing the think-aloud data with other process information. However, the use of eye movement measures required the provision of electronic facilities which were not accessible to the present researcher for the first phase of the research carried out in Iran.

Nevertheless, one way to partially solve the problem is through instant framing of the retrospective questions by observing those strategies used by the informants during the think-aloud task which present problems to the analyst. Thus, after the subjects had finished their think aloud task, they were asked questions about the strategies they employed during introspection. The purpose of asking subjects to comment on some of their strategies was to

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confirm if they matched my inference about these strategies. However, questions asked in the retrospection section were not comprehensive enough to cover all problematic areas of the introspection task. This was, of course, one of limitations of this study.

#### **4.5.6. Response Classification Scheme**

An important issue in analyzing think-aloud data relates to categorizing identified strategies. That is, to exhibit individual differences and commonalties in reported cognitive processes of skilled and novice second language readers, one needs to devise response classification schemes. The main underpinning of such classifications is to observe what processes and strategies are used frequently or otherwise, and the type and nature of these processes and strategies, so that they can be used for diagnostic and instructional purposes. Such classification in fact represents a theory, as Afflerbach and Johnston assert and can be drawn from the data. It can also be determined prior to data analysis, That is, pre-existing categories can be considered and protocol responses are classified based on these taxonomies.

Previous studies of strategy identification indicate a variety of such categorizations. Block, for example, identifies two levels of strategies: general comprehension and local linguistics. Sarig identified four types of reading

moves (or strategies) mainly: technical-aid, clarification and simplification, coherence-detecting, and monitoring moves. Olshavsky talks about three levels of strategies viz. word, clause, and story. Johnston and Afflerbach identified two main groups of strategies: dimensions monitored and consequent actions. Recently, transcribing the protocols and including comprehension strategies reported in past strategy research, Kletzien (1991, see also chapter two) presents a classification scheme comprising strategies such as using syntax, using the author's style, using known phrases, rereading previous text, to name a few.

#### **4.6. The Data Analysis Model**

The protocol data which were originally produced in the subjects' first language (that is, Farsi) were all rendered in English by the present researcher. The data were then analyzed along two dimensions namely: encoding, and coding.

In the encoding phase the verbal reports were segmented into verbalizations of heeded thoughts. No particular linguistic system of encoding which suggests the verbal reports be segmented at phrasal or sentential level was applied. Instead, verbalized units were segmented whenever a pause in articulation



such as phonemic intonation contours and a slight pause in verbalization were noticed. An example is as follows:

*/I don't know this word/ 'obtain'/.*

The above verbalization in fact consists of two independent verbalized units. The first one which is a full sentence is segmented by a slight pause at the end of the sentence while the second one is an apparently unknown item of vocabulary segmented when followed by a rising intonation. In order to account for features of articulation such as intonation, stress, pauses as well as other important features in encoding the verbal reports, a list of key symbolic features was produced as follows<sup>5</sup>:

### **Symbolic Figures Used in the Think Aloud Protocol Data**

*italic words* = utterances produced originally in English by the subjects

[( )] = utterances produced and information given by the researcher

/02/ = time seconds

↖? = self-directed question

?→ = researcher-directed question

/ = utterance boundary

' ' = utterances read in English as it originally appeared in the text

S4 = sentence number

↗ = rising intonation

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<sup>5</sup> Sample full passages encoded in this way are to be found at Appendix B.

∨ = falling intonation

————→ = quick reading rate

~~~~~ = slow reading rate

==== = emphatic expression

WFWT = word for word translation

RA = reading aloud

RRA = resume reading aloud

RLV = reading in a low voice

LFV = laughing voice

.....MT.... = muttering

/ / = pronunciation boundary

~~~~~ = decoding

RS = reading silently

The second phase of analyzing the data relates to coding the verbalized units. Segmenting verbalized units independently of those that precede and follow it without attention to context was possible but this independence of protocol segments from context seemed to be incomplete. For example, pronouns and descriptive phrases can often only be interpreted in the context of the preceding verbalizations. Moreover, an expression of failure followed by the relevant reasoning can hardly be viewed independently. The following verbalization clearly exemplifies this:

| Text 1                             | protocol                    |
|------------------------------------|-----------------------------|
| However, all the green species are | RS/ 017/ when I face a long |

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unable to synthesize at least one organic substance that they need, and they must obtain these substances osmotrophically. sentence like the one here/ 02/ I forget what it was all about/ um/ in my mind/ 02/ when I reach the end of sentence/

As can be seen, the protocol consists of five verbalized segments separated by time intervals between each verbalization. Coding each segment as an independent verbalization would be misleading. The coding is much easier and unequivocal if we consider the context of the whole brief episode at once, instead of encoding the individual statements ignoring that context. Therefore, it was often felt necessary, when coding protocol segments, to take into account the wider or narrower context of each segment. Care was also taken not to take data twice as evidence.

However, problems emerged as soon as I decided to categorize the strategies. First, while some of the strategies were found to have an overlap with other strategies identified by Sarig, for example, some did not. Therefore, I initially decided to employ Sarig's classification of strategies which included technical-aid moves, clarification and simplification moves, coherence-detecting moves, and monitoring moves. The strategies identified in this study consisted of different process components (or four higher-order processing including prior knowledge, metacognition, inferencing, discourse processing and three lower-level processing comprising word recognition, phonemic/graphemic decoding and syntactic processing) and seemed to fit nicely in the classification proposed

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by Sarig. However, problems presented themselves in the final stage of analyzing the reading strategies to be taken as evidence for supporting the reading theory of this study. For example, while Sarig's technical aid moves category can cover many of the techniques used by the readers during reading comprehension such as underlining, it cannot be considered a reading process component. Nor does her classification represent a reading theory wherein top-down and bottom processes are clearly accounted for. Some of these techniques are also identified in this study (that is, highlighting for reprocessing) but their main function is discussed in terms of the purpose for which they are utilized rather than their merits as a technical aid. For example, highlighting for reprocessing is discussed because of the subjects' intention to infer the meaning of the highlighted text. Under Sarig's categorization and in order to account for the strategies within the framework of the reading theory of this study, I, therefore, needed to recategorize the strategies but this would have required a further unnecessary step.

Bearing in mind that strategy classification could in fact represent a theory (Afflerbach and Johnston, *op.cit.*), I started to reclassify the strategies but this time under the rubric of the reading process components of this study mentioned in chapter 3 to avoid further recategorization.

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The coding of the verbal reports was, therefore, done based on the general principles of reading as an interactive process wherein higher order processes including prior knowledge, metacognition, inferencing, and discourse processing come to interact with lower processes comprising word recognition, phonemic/graphemic decoding, and syntactic processing. But that was only an initial coding of the strategies based on my own knowledge of strategy categorization. A further step was needed and that was an examination of the strategies with other raters who were supposed to interpret and name the strategies based on their own understanding. However, in giving the protocols to the raters, some practical problems emerged which were the result of the nature of the experimental texts. The first problem was related to the length of the texts used in this study. The texts particularly T3 was a journal article comprising up to 11 dense paragraphs which was, to the best knowledge of the present researcher, lengthier than any other texts used in other studies using introspection as their method of investigation. Thus, giving the full transcribed versions of the texts to the raters was implausible, if not impossible. Another option was to take a few samples of full transcribed protocols and give them to the raters to comment on. That option appeared to have its own problems. One important problem was that while some strategies were present in the protocols some were not. The only good solution was to

provide the raters with two samples of each strategy identified by the present researcher from the protocols. An example is given below:

| Text   | Protocol   |
|--|--|
| The problem is well-illustrated by the various species of protozoans that are grouped together in the genus <i>Euglena</i> . | /here 'well-illustrated' means to encourage, I think/ RRS/ 04/ 'illustrate' means to design/ ok well-designed/ well-expressed/ |

Therefore, after the protocols were divided into separate segments, the protocols together with their relevant texts were given separately to two independent assessors who were invited to identify and name the strategies being used by the subjects in each case. The protocols were ordered randomly, to eliminate the possibility that the encoders would rely on information in preceding segments to make subsequent decisions. After each assessor had completed this task, a further session was organized with each judge to discuss those strategies on which there appeared to be a divergence of judgment. With the exception of three strategies which were evaluated differently by the judges, we reached a common agreement about the core function of the strategies and the different terminologies to describe the same function which had occasionally been assigned to some strategies were reconciled. Many of the strategies identified were quite similar to the ones identified in previous studies including Olshavsky, Johnston and Afflerbach, Block, Scardamalia and Bereiter (1984), Sarig, Hosenfeld. Therefore, some of them bear the same



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terminology. For example, Olahsvsky identified synonym substitution (used in this study as *L1-equivalent search*), rereading (used here as *reprocessing*); Johnston and Afflerbach identified monitor for meaning (used here as *reprocessing to get the gist*), processing in the hope of later resolution (which pertains to *controlled skipping* of this study). Block found recognizing text structure (used here as *predictive recognition of text development*), integrate information (referred to here as *relating*), question information (used here as *self-directed questions*), using general knowledge and association (referred to here as *using background knowledge*), paraphrase (used also here as *paraphrase*). Bird found setting up 'watchers' (used here as *watchers*). In addition to many of the above strategies, Sarig also found slowing down and using sing-song intonation to facilitate comprehension (used in this study as *integrated decoding*), repeating reading of the same decoding unit (referred to here as *repeating to get word meaning*), deserting a hopeless utterance (used here as *identification of comprehension problems either at word or sentence level*), differential marking for different purposes (used here as *highlighting for reprocessing*), raising redundancy level by means of syntactic simplification (used here as *syntactic analysis*). Hossenfeld also identified a range of strategies such as skipping words that may add relatively little to total meaning (referred to here as *skipping trivial sections*), and word for word translation (used here as *word for word translation*). Taking into account the

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three strategies mentioned above, a coefficient of 95% agreement was achieved from the raters' judgment. What comes below includes an operational definition for each strategy and monitoring statement together with an example of their corresponding verbal reports. These will be discussed in the strategy description section in the next chapter.

## Higher-Level Processing Strategies

| <b>Prior Knowledge</b>                     |   |   |
|--|---|---|
| <b>Strategy</b>                            | <b>Operational Definition</b>   | <b>Example</b>  |
| Using background knowledge                 | This refers to the reader's knowledge about the world, and the content of the text, which clearly bring extra information to text processing.     | /aha/ they are produced with more or less degree of difference/ the new members are related to the another/ O2/ to the cell mother with more or less degree of difference/ regarding my background knowledge about sexual and asexual reproduction I got it/ but I'd better tell you this/ um/ that if it was not for my background knowledge I would certainly have problems in processing the sentence/ |
| Predictive recognition of text development | The strategy refers to the reader's anticipation of the incoming text based on his/her knowledge about certain linguistic information in the text | /I think the next sentences are going to discuss the result of the systematists' investigations/  |

### **Metacognition**

|                             |   |   |
|-----------------------------|---|---|
| Self-directed questions     | This refers to questions posed to oneself accompanied by rising intonation with the purpose of clarifying a problem in comprehension.   | /i.e./ 'i.e. chloroplast/ what abbreviation is it?'/ I wish he could explain it/              |
| Skipping trivial sections   | The strategy shows the reader's identification of trivial sections of the text and therefore his/her decision to skip them.   | /I skipped the rest of the paragraph cause it does not present important material/            |
| Skipping difficult sections | The strategy reflects the reader's decision to skip difficult sections be it a lexical item or a phrasal unit.  | /I don't know 'obviously'/ of course it is an adverb/ yet I can ignore it/                    |
| Controlled skipping         | This refers to the reader's attempt to unravel the meaning of an unknown linguistic item, be it a word or a phrase or a sentence by consciously skipping it and resorting to contextual information which comes late. | /I don't know this 'hierarchically'/ in spite of all this I go forward to see what I can get/ |
| Paraphrasing                | This refers to a full account of a target sentence rendered in first  | /a few number of scientists investigate/ em/ a  |



|                          |   |  |
|--------------------------|---|--|
|                          | language.   | large number of organisms in systematics/  |
| Paraphrase with deletion | The strategy shows a tendency in the reader to leave difficult parts aside in his/her interpretation of the sentence rendered in first language which is accompanied by reshaping the meaning of the unprocessed parts. | /this applicability/ applicability of model organism based on the comparison with other organisms / this can be inferred by comparing it with other organisms/ |

### Monitoring Statements

|  |   |   |
|--|---|---|
| Problem identification at sentence level | The statement shows the reader facing problems with a sentence expressed either directly or indirectly. | / I don't understand this sentence/     |
| Problem identification at word level     | The statement shows the reader facing problems with a word expressed either directly or indirectly.     | / I don't know what 'substances' means/ |

### Inferencing

|                                  |   |   |
|----------------------------------|---|---|
| Reprocessing to get the gist     | The strategy represents the reader's attempt to understand the gist of a given sentence by rereading it.  | /I want to read the sentence again to get what it really says/ I mean to get the gist/  |
| Reprocessing long structures     | The strategy refers to the reader's problem with long sentences which requires him/her to reprocess in order to get the meaning of the sentence.  | /I read from the beginning/ it was a long a sentence/   |
| Reprocessing to assemble         | This refers to the reader's attempt to use every source of information within the sentence through reprocessing to assemble different parts of the sentence which are apparently familiar to the reader but could not be formed to present a coherent meaning representation. | /O10/ the rest of the sentence/ words are familiar but I don't have a general view/ I read it again                                     |
| Reprocessing to get word meaning | This refers to an act of reprocessing to use every possible source of information in the sentence to infer the meaning of an unknown item of vocabulary.  | /now I reread the sentence to see if I can understand 'ack'/  |
| Highlighting for reprocessing    | The strategy reflects the reader attempt to use technical aids of highlighting for the purpose of reprocessing.   | /I highlight this sentence for later processing/  |
| Inferencing                      | This refers to the reader's use of information surrounding an item of linguistic information particularly an unknown lexicon to come to understanding.  | /I don't know the meaning of 'unambiguous'/ but from the information in the sentence I guess it is equivocal or something like unclear/ |
| Watchers                         | The strategy refers to the reader's attempt to keep an unfamiliar   | /here again we have 'ack'/ O2/ which is as  |

|                                       |   |   |
|---------------------------------------|---|---|
|                                       | item of vocabulary in mind to be tackled later on by getting help from incoming information.  | ambiguous as before/  |
| Identification of comparison/contrast | The strategy clearly shows the reader's ability to identify comparison/contrast structures in the text by relating and comparing them to form meaning representations.          | /04/ in discussing systematics unlike the previous paragraph in which the evolutionary investigations required a limited number of organisms here a vast number of animals are studied by scientists/ |
| Repeating to get word meaning         | The strategy includes an act of retrieving or guessing the meaning of a problematic item of vocabulary from long term memory by repeating it to oneself usually in a low voice. | /osmotroph/ 'osmotroph/' is a bit unfamiliar to me/   |

### Discourse processing

|                        |   |   |
|------------------------|---|---|
| Main idea construction | The strategy reflects the reader's understanding of bigger linguistic information, that is, paragraphs, in his/her construction of the main idea of each paragraph. | /035/ um/ the main idea of the paragraph is that they have used certain organisms as models in order to determine others/ |
| Relating               | This refers to an attempt to relate two and on some occasions more than two items of information in the text to each other.   | /012/ I reread this sentence cause I wanted to relate it to the previous sentence/  |

## Lower-Level Processing Strategies

### Word recognition

|                           |  |   |
|---------------------------|--|---|
| L1-equivalent search      | This refers to the reader's attempt to understand a target word by seeking an appropriate word equivalent in first language from long term memory.   | /it says that 'comparative biologists/' biologists who do analogy/ evolutionary biologists/ systematics biologists/ |
| decoding                  | This refers to any move to tackle a problematic item of vocabulary uttered in a low voice by breaking it into syllables and often repeating it.  | '/by various species/ 'of protozoans', /<br>'protozoans' /  |
| Word for word translation | The strategy is an attempt to maintain text processing by reading word by word and sometimes phrase by phrase and giving an equivalent first language account of each phrase at the end of it. | 'the plants/' WFWT/ 'can use/WFWT/ 'this energy/' WFWT/ 'because/' WFWT/ 'they possess/' WFWT/ 'chlorophyl/' WFWT/  |



|                               |   |   |
|-------------------------------|---|---|
| Researcher-directed questions | The strategy refers to any situation in which the reader feels that a linguistic item requires either clarification or confirmation by resorting to the most available source of getting that information, that is, the researcher. | /then I thought a bit and I thought that some plants are carnivarous/ perhaps it is the right meaning/ isn't it?→ |
| Using dictionary              | The strategy refers to the simple act of referring to dictionary to look up the meaning of an unknown item of vocabulary.   | /I don't know 'lack'/ I refer to dictionary/  |

### **Phonemic/graphemic decoding**

|  |   |  |
|--|---|--|
| Word identification based on phonological similarity | This shows the reader's attempt to get the meaning of an unknown lexical item by comparing it to its closest possible neighbor which bears some phonological similarity less often accompanied by a self-directed question.   | /survive/'service'/?/  |
| Integrated decoding                                  | The strategy shows the reader's attempt to get the word meaning of an unknown item of vocabulary by an initial slow decoding process followed by rising and falling intonations. At times the procedure could be reversed, meaning that the reader used a rising and falling intonation followed by decoding. | / 'evolution' / 'evolution'↑ 'evolution'↓<br>'evolutionary theory' / |

### **Syntactic processing**

|                      |   |   |
|----------------------|---|---|
| Grammatical analysis | The strategy involves parsing a problematic syntactic structure ranging from phrasal to sentential structures with the purpose of making a comprehensible interpretation of the text. | /then/ 02/ 'well-adapted' is a compound sentence/ I read it this way that something which is adapted well/ then it is preceded by 'less'/ it is negated/ it can adapt itself/ less/ then I can get it in this way that individuals which can adapt themselves less/ |
|----------------------|---|---|



The monitoring statements as well as reading strategies were then calculated for the frequency of occurrence to determine which strategies were the dominant ones in the readers' text comprehension processes and which were not. To determine the frequency of occurrence of the monitoring statements and reading strategies two more criteria were set. The reading strategies and monitoring statements which occurred only once was not considered in the frequency table. Besides, strategies which were used by only one subject were not considered in the frequency table too. Therefore the strategies which occurred only once across subject and strategy were only taken as instances of the use of that strategy. The reading strategies and the monitoring statements were therefore tallied.

#### **4.7. Summary**

This chapter mainly dealt with the procedures for employing think aloud methodology to the target population. It discussed different issues about subject selection, selection of the appropriate material, and theoretical issues concerning the number of subjects and verbalization in the first language. Certain other issues were raised such as managing the experimental sessions and the extent to which the researcher's interference in the form of probing in verbal reports was justified. The section also dealt with the model of data analysis.

# Chapter Five

## Results and discussion

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# RESULTS AND DISCUSSION

## Section I

### 5.1. Introduction

The chapter of results and discussion is divided into three sections. The first section deals with quantitatively classifying the strategies identified. The section follows with a qualitative explanation of the cognitive strategies identified. The data to be represented also consist of excerpts taken from think-aloud protocols that were taken as being representative of the reading for meaning strategies used. The representative excerpts also include the related texts as well as commentaries given to each strategy. The second section portrays individual profiles of the novice and the skilled readers which provide an answer for the issue of individual differences in reading. Based on the hypotheses posed earlier, section 3 provides the quantitative results of the reading strategies used by the novice and skilled foreign language readers of this study.

### 5.2. Proportion of Reading Strategies

The strategies identified in this section are categorized under the proposed theoretical categories reported earlier in chapter 4. The following table shows frequency of reading strategies used by the novice readers. As the above table reveals the highest<sup>1</sup> proportion of the strategies belongs to repeating to get word

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<sup>1</sup> The statistical notions of 'high' and 'low' have local interpretations here only in comparison to the proportion of the rest of the strategies. That is, if a given strategy X has a

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meaning (i.e. 21% of all strategies). Next to the above strategy is word for word translation with a percentage of 17 across strategies.

| Category                           | Strategy  | Frequency | %    |
|------------------------------------|---|-----------|------|
| Prior Knowledge                    | Using background knowledge                                | 17        | 4*   |
| Metacognition                      | Self-directed questions                                   | 36        | 8    |
|                                    | Skipping difficult sections                               | 11        | 2.5  |
|                                    | Controlled skipping                                       | 14        | 3    |
| Inferencing                        | Reprocessing to get the gist                              | 21        | 5*   |
|                                    | Reprocessing long structures                              | 4         | 0    |
|                                    | Reprocessing to assemble                                  | 18        | 4    |
|                                    | Reprocessing to get word meaning                          | 43        | 10   |
|                                    | Inferencing   | 16        | 3.7  |
|                                    | Watchers  | 6         | 1    |
|                                    | Repeating to get word meaning                             | 90        | 21   |
| Word recognition                   | L1-equivalent search                                      | 7         | 1.5  |
|                                    | Decoding  | 18        | 4    |
|                                    | Word for word translation                                 | 73        | 17   |
|                                    | Researcher-directed questions                             | 10        | 2.5* |
|                                    | Using dictionary  | 11        | 2.5  |
| Phonemic/<br>graphemic<br>decoding | Word identification based on -<br>phonological similarity | 11        | 2.5  |
|                                    | Integrated  | 9         | 2    |
| Syntactic processing               | Grammatical analysis                                      | 14        | 3    |
| Total                              |   | 429       | 100  |

Table 5.1. Frequency of reading strategies used by the novice readers. \* rounded

percentage of 10, for instance, while other strategies have lower percentages than that therefore this strategy represents the highest proportion in relation to the proportion of other strategies.

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The third highly utilized strategy is reprocessing to retrieve word meaning with a percentage of 10. Other strategies that were used with lower percentages are reprocessing to get the gist (5%), reprocessing to assemble (4%) and decoding (4%). Still having lower proportions than the rest are activating background knowledge (4%), inferencing (3.7%), grammatical analysis (3%), controlled skipping (3%), word identifications based on phonological similarity (2.5%), skipping difficult sections (2.5%), using dictionary (2.5%), researcher-directed questions (2.5%), integrated (2%), L1-equivalent search (1.5%), watchers (1%) and finally reprocessing long structures with the lowest proportion of almost nil.

The skilled readers also used a variety of reading strategies in their attempts to solve comprehension problems. These strategies are paraphrasing (30.5%), reprocessing to get the gist (14%), skipping trivial sections (10%), highlighting for reprocessing (7.5%), paraphrase with deletion (7%), repeating to get word meaning (5.5%), main idea construction (5%), inferencing (3%), activating background knowledge (2.5%), self-directed questions (2.5%), L1-equivalent search (2%), controlled skipping (2%) predictive recognition of text organisation (1.7%), reprocessing long structures (1.5%), identification of comparison/contrast (0%), and relating (0%). The most frequently used strategy is paraphrasing with 30.5% while the least frequently used strategy is

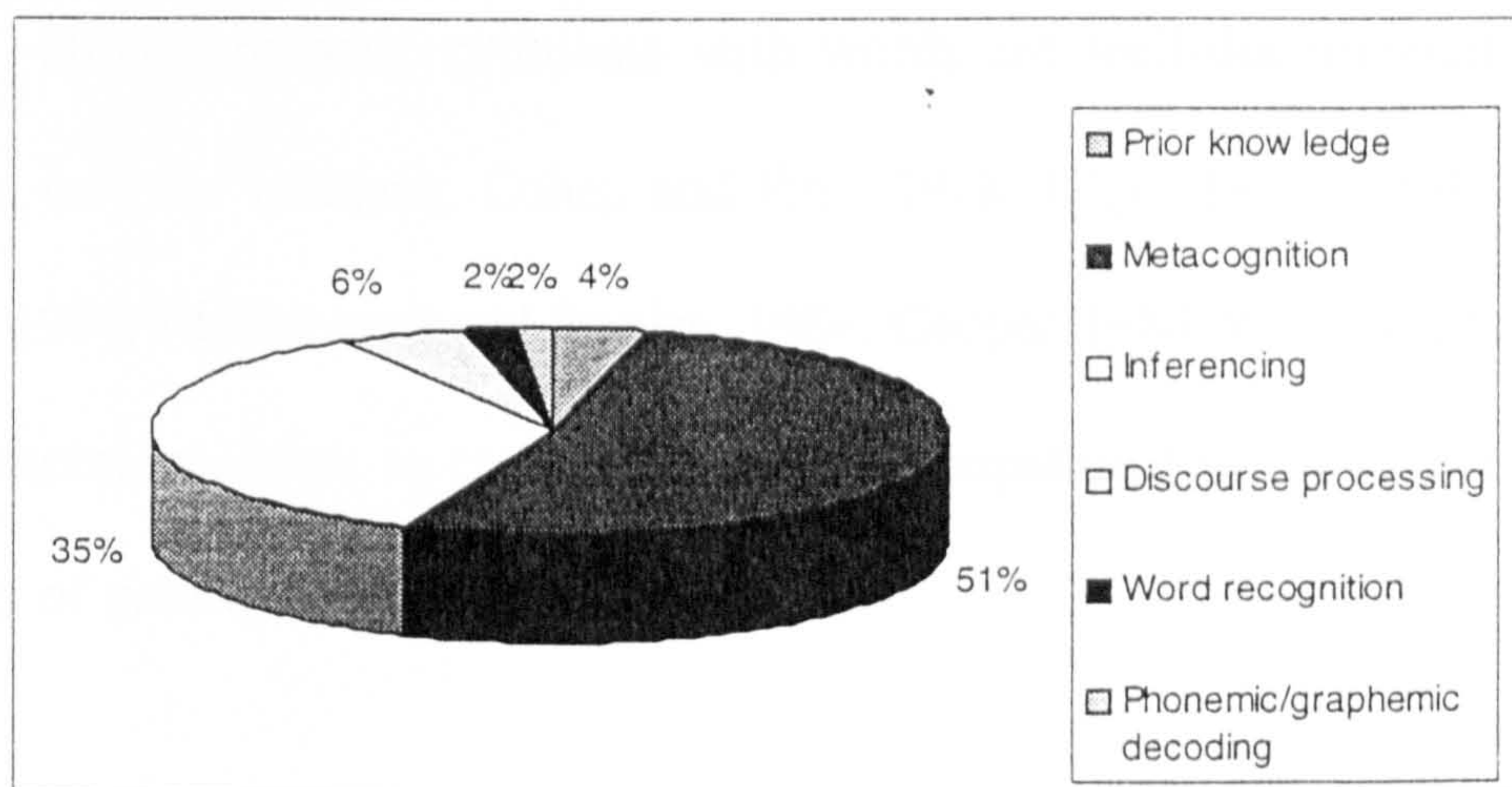
relating and identification of comparison/contrast each with almost nil proportion across strategies.

| Category<br>%               | Strategy  | Frequency |      |
|-----------------------------|---|-----------|------|
| Prior knowledge             | Using background knowledge                        | 11        | 2.5* |
|                             | predictive recognition of text development        | 8         | 1.7  |
| Metacognition               | Self-directed questions                           | 12        | 2.5* |
|                             | Skipping trivial sections                         | 50        | 10   |
|                             | Controlled skipping                               | 9         | 2*   |
|                             | Paraphrasing                                      | 149       | 30.5 |
|                             | Paraphrase with deletion                          | 33        | 7*   |
| Inferencing                 | Reprocessing to get the gist                      | 68        | 14   |
|                             | Reprocessing long structures                      | 7         | 1.5* |
|                             | Reprocessing to get word meaning                  | 12        | 2.5  |
|                             | Highlighting for reprocessing                     | 37        | 7.5  |
|                             | Inferencing                                       | 15        | 3    |
|                             | Identification of comparison/contrast             | 4         | 0    |
|                             | Repeating to get word meaning                     | 27        | 5.5  |
| Discourse processing        | Main idea construction                            | 23        | 5*   |
|                             | Relating  | 4         | 0    |
| Word Recognition            | L1-equivalent search                              | 10        | 2    |
| Phonemic/graphemic decoding | Word recognition based on phonological similarity | 8         | 1.7  |
| Total                       |   | 487       | 100  |

Table 5.2. Frequency of reading strategies used by the skilled readers.  
\*rounded



Comparing the proportions of categories of strategies used by the skilled and novice readers, the following points strike attention. First, the skilled readers are distinguished from the novice readers in terms of greater attention to *metacognitive* aspect of the reading. The skilled readers show a better control over reading comprehension than the novice readers (see figure 5.1. below).



**Figure 5.1. Proportion of categories of strategies observed in skilled readers' protocols.**

Another striking aspect of text processing is the absence of *discourse processing* in the novice readers' processing of the text. The implication is that, having acquired a better lower-level processing, the skilled readers free more attention capacity to deal with global aspects of text. The novice readers, on the other hand, due to stronger engagement with word identification are less facile in dealing more with global aspects of text, that is,



discourse processing. Interestingly enough, the novice readers' use of *inferencing* (i.e. 46%) is higher than *word recognition processing* (i.e. 28%) which comes as the second frequently-used category of reading strategies (see figure 5. 2.). A striking over-reliance on higher order processing by the novice readers presents itself in the form of repeating to get word meaning (i.e. 21% of all strategies) which is a clear sign of failure in decoding by the novice readers. Novice readers' problems with words are well-documented in the literature (see for instance, Cohen and Fine, 1978; Ulijn, 1980; 1984; Albert-Dewolf, 1984; Mohammed and Swales, 1984; Cooper 1984 all in chapter two). Words, therefore, seem to create a major preoccupation for novice readers in their way of getting meaning of text.

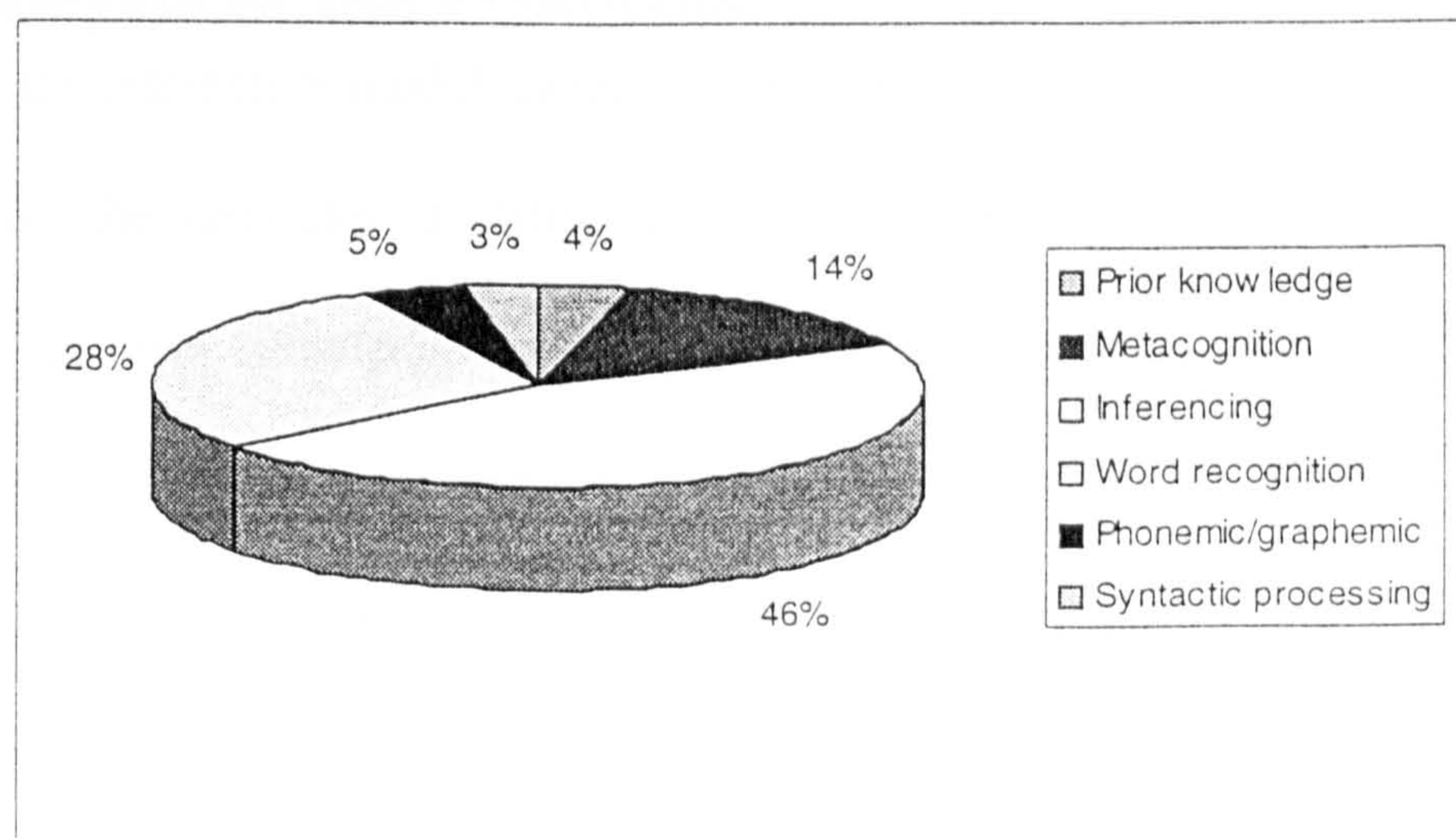


Figure 5.2. Proportion of categories of strategies observed in novice readers' protocols.



The skilled readers, on the other hand, contributed the least proportion of their strategies to word recognition (i.e. 2%) while paying greater attention to inferencing with a proportion of 27% presenting itself in the form of reprocessing to get the gist (i.e. 14%).

On the other hand, while three percent of the novice readers' processing capacity is occupied by *grammatical analysis*, the skilled readers showed no evidence of using syntactic processing in their performance. As McLaughlin (1987b) argues, more proficient readers due to developing a threshold of syntactic proficiency process structure and form in the text automatically.

### **5.3. Analysis of the Protocols**

Based on the interactive model mentioned in chapter three, the following section accounts for the strategies identified in this study. Therefore, the strategies are classified into prior knowledge, metacognition, inferenceing, discourse processing, word recognition, phonemic/graphemic decoding, and syntactic processing. In response to the hypothesis posed in chapter three concerning identifying the strategies used by both novice and skilled readers, it was found that some strategies were used only by the novice readers, some only by the skilled readers, and some shared by both groups. Therefore, the following letters n, s, and c standing for novice, skilled and common strategies respectively were used in



parentheses attached to each strategy label. It also deserves attention to note that some of the strategies classified under the following scheme overlap with other strategies.

### 5.3.1. Prior Knowledge

#### 5.3.1.1. Using Background Knowledge (c)

As the majority of reading research findings in the field of first and second language reading confirm, an activation of background knowledge helps readers process a given text. The novice and skilled readers of this study activated their background knowledge to assist comprehension. An example of the technique is as follows:

| Text 2  | Protocol   | Commentary   |
|---|--|--|
| S27: The most important feature of this physical continuity between generations is the passing on of chromosomes. | /ok/ now/ it says something about reproduction and 'passing on of chromosomes'/ aha/ it is talking about the same cell division that I had in my mind/ | <i>The subject clearly resorts to his/her academic background knowledge to help in processing a rather difficult sentence.</i> |

As the above protocol shows, the technique is often accompanied by the expression 'Aha' which represents an activation of background knowledge matched with the information present in the sentence. In fact, this particular expression was observed in all instances of the novice subjects' protocols which

shows the subject's realization that they were finding a solution to a comprehension problem. In the protocol above, NI4 uses the original English phrase of 'passing on of chromosomes' in her interpretation of the sentence which obviously indicates her problem in interpretation. It is only after activating her background knowledge (or content schemata) backed by the phrase 'aha' showing her satisfaction at success that she comes up with its correct interpretation. An important point to be mentioned here is that activating previous knowledge (here, content schemata) can not only promote comprehension but also encourage the reader to proceed, as NI2's statement on S13 of T1 shows:

**/By the various species of protozoans that are grouped together in the genus Euglena/ aha/ our own Euglena/ it is the strength of heart /LFV/ I returned to 'illustrated'/ cause I must think on it/ cause after all it is a pity to leave this word here and not to understand the sentence/**

The protocol data showed that the strategy was extensively utilized by four novice readers of whom three were female (i.e. NI1, NI4, NI7) using 15 strategies out of the total 17 occurrences of the strategy and the other one was a male (i.e. NI5). The application of background knowledge by the female reader informants of the study may open avenues for further research to test whether there is a relationship between sex and activation of background knowledge.

It was observed that the mere activation of previous knowledge may not necessarily lead to understanding. An explanation for this can be found within the interactive theoretical model of Rumelhart (1977) that explains that all interacting processes share a total system of limited capacity. Thus, regardless of the facilitative function of bottom-up and top-down processes and the influence of one on the other, they may also interfere with each other depending on the amount of the system's total resources they each require (e.g. top-down processes may be lessened if more resources are utilized by bottom-up processes<sup>2</sup>). Carrell (1988) discusses this phenomenon in terms of unidirectional processing in either totally top-down or bottom-up processing directions that may interfere with second language readers' interactive processing of the text. In this regard, an instance of unskillful over-reliance of N15 on his background knowledge could be seen in the following verbalization:

**Text 1**

S5: Animals, on the other hand, must obtain complex organic substances by eating plants or other animals.

**Protocol**

/this 'eating plants' was a bit questionable to me/ then I thought there are a series of plants that are carnivorous/

In the above protocol, the subject misinterprets the preposition-gerund construction of 'by eating plants' as gerund functioning as an adjective and readily

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<sup>2</sup> In reading research this notion is called 'bottlenecks' and has inspired considerable research (e.g. Smith, 1971).



surrenders to his background knowledge and does not pay attention to deeper linguistic analysis of the phrase. On the other hand, an example of over-reliance on textual analysis is NI7's protocol of the following piece of linguistic information:

## Text 2

## Protocol

S23: How long an individual survives depends partly on chance and partly on whether it has any advantage over other individuals.

it says how long an '*indivaidual*', in a division form/ perhaps it means fission /

The word 'individual' is pronounced as *indivaidual*. The wrong pronunciation has activated a wrong phonological code that led to misunderstanding of the whole word and therefore wrong interpretation of the sentence. That is, the subject matches the word individual with the word 'divide' and hence makes a hypothesis that takes it as a form of division in cells that is in the scientific term called 'fission'. It is, therefore, possible that the laborious decoding of the term 'individual' and its wrong pronunciation has left too little capacity for effectively executing knowledge-based processes.

Concerning the facilitative nature of using background knowledge in text processing, SI4 identifies areas of shared knowledge with the text and confirms his good understanding of those areas as in S56<sup>3</sup>:

**Text 3****Protocol**

S56: However, from a phylogenetic and morphological perspective, *Xenopus* is a member of a basal, extremely modified family of frogs that are unique and bizarre in most aspects of their biology.

/RA/ ok/ it is quite clear to me/ that is I understand better those areas that are related to my field than those which are not/

**5.3.1.2. Predictive Recognition of Text Development (s)**

Coined by Sarig (1987) and used under the same name here, the strategy is an indication of employing an advanced reading strategy to text comprehension.

An example of the strategy is as follows:

**Text 3****Protocol****Commentary**

S83: The second link between these two disciplines is the use of phylogenies to evaluate the generality of model organisms.

/the next paragraph will discuss the second link of this approach/

*The subject based on his/her familiarity with textual schemata norms recognizes text organization.*

SI6 clearly incorporates his knowledge about text structure and uses context in constructing a representation of the text. This knowledge about text is also

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<sup>3</sup> See chapter 2 section 1. for a review of the role of background knowledge in text processing.

called formal schemata in the literature of schema theory. Such knowledge refers to the formal, rhetorical organisational structures of different types of texts. The strategy shows that although the subject uses signals such as 'the second link...]' as clues to help him focus on main information (Brown, et al., op.cit.), there is no evidence showing that the subject used a sampling strategy to predict the next paragraph. Skilled readers know about such devices and use them to focus more on the information in the text. It is possible to assume that the skilled reader above processed the text automatically which had caused no trace in verbalization about bottom-up processing.

In sum, using background knowledge to tackle problems of comprehension is reflected in activating previous knowledge about the content of the text. The facilitating effect of such knowledge has already been discussed. In addition, it was discussed that both the skilled and novice readers used this strategy in their text processing. An incorporation of knowledge about the text is reflected in the predictive recognition of text development. In fact, the subject based on his/her knowledge about the text structure makes an inference and uses context in constructing a representation of the text.

### **5.3.2. Metacognition**

#### **5.3.2.1. Self-directed Questions (c)**



An important monitoring strategy that has recently received attention in cognitive reading research study is self-interrogation or questions which readers pose to themselves. It is believed that such a strategy is one way to facilitate learning from a text during reading (Baker and Brown, 1984). Andre' and Anderson (1978-1979) developed and tested a self-questioning study technique in which *first* language high school students were taught to locate sections of text containing important points and generate questions about them. They found that generating such questions facilitated learning better than simply reading and rereading the text or making up questions without regard to important points. In addition, the training was more effective for students of lower ability, suggesting that the better students had developed effective self-questioning techniques of their own. Andre' and Anderson suggest that self-questioning may be more effective than such passive strategies as rereading because it incorporates many metacognitive components. This means that it encourages the reader to (a) set purposes for study, (b) identify and underline important segments of the material, (c) generate questions which require comprehension of the text to be correctly answered, and (d) think of possible answers to the questions. As Baker and Brown maintain, 'the questioning strategy leads the student to an active monitoring of the learning activity and to the engagement of strategic action' (P:372). An example of the strategy used by the novice reader informants is as follows:

| Text 1  | Protocol  | Commentary  |
|---|---|---|
| S5: Animals, on the other hand, must obtain complex organic substances by eating plants or other animals. | /RS/ 07/ there is a structure here/ 'must obtain complex organic substance'/ 03/ should I take it as a sentence <sup>RA</sup> ?/ or as a word <sup>RA</sup> ?/ should I take it as a structure to which 'complex' is added <sup>RA</sup> ?/ | <i>The strategy shows the subject's posing questions to self to solve a grammatical problem by taking different approaches to the text.</i> |

Obviously, the importance of such questioning becomes clear when the relevant questions are asked of oneself. As Collins et al. (1980) suggest many failures of comprehension are in fact due to a failure to ask the right questions. As the above protocol data show, NI1 is unable to consider the structure as a sentence, a word or a general structure in which the adjective 'complex' is added. The above think-aloud data present nothing more than the subject's confusion as to what grammatical structure is to be posed in order to be meaningful.

This strategy is a late-developing cognitive skill acquired in puberty and does not seem to have a relationship to second language proficiency. An important implication of the strategy for the novice reader is that they exhibited control over monitoring their comprehension. In fact, as the protocol data of both groups reveal, the novice readers employed it more frequently than the skilled readers (that is, 36 vs. 12 respectively). It is however interesting to note that the majority of uses of this reading strategy was used by the female reader

informants (i.e. NI1, NI3, NI4, and NI7). The only male novice reader who used this strategy was NI2. The implication of this finding for research on second language reading is to test the finding of this study. Within the theoretical framework of this study, self-directed questions are instances of employing monitoring strategy.

### 5.3.2.2. Skipping Trivial Sections (s)

Skipping trivial sections of the text was used by the skilled reader informants. Below is an example of the strategy. As the protocol shows, SI5 skips S25 that adds relatively little to the total meaning. Such a move is based on his separating important from unimportant linguistic information contained in the text. However, due to automatic processing of the text, the subject retains no trace of bottom-up processing in the following verbal report.

| Text 3   | Protocol  | Commentary   |
|--|---|--|
| <p>S25: In the remainder of this paper, we briefly summarize some of our own ideas on why systematists and laboratory biologists can and should help each other in the quest for general patterns and mechanisms in biology.</p> | <p>/ I don't spend time on it/ cause it doesn't reveal important information/ cause I got the theme in the past paragraphs/</p> | <p><i>The subject separates important from unimportant details and skips the trivial sections.</i></p> |



Therefore, it seems clear that the subject tries to save his energy for tackling the rest of the text thus giving more free attention to resolve other information by refraining from spending time on repeated trivial information in the text processed automatically. A similar strategy was observed in Hosenfeld's (1977) introspective study in which she noticed that her subject skipped words that were thought to contribute little to total meaning.

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The shift of attention from unimportant to important points in the text is said to indicate an advanced application of the strategy (Brown et al., 1986). They contend that the ability to regulate one's allocation of attention reflects mastery level and is a late developing skill achieved by a co-ordination of various forms of knowledge. Brown et al. (P:61) define these forms of knowledge as:

'(1) information concerning current knowledge, i.e. what is known and not yet known; (2) knowledge of the task demands; (3) knowledge of the relative importance of various elements of texts, i.e. what is important to know and what can be disregarded; and (4) the strategic knowledge to adjust allocation of effort in response to the above information'.

What seems to be clear in the subject's strategy application is the presence of monitoring comprehension. His awareness of the task, that is, reading for meaning, is reflected in his decisions to ignore automatically processed trivial sections and look for other significant information. Therefore, within the

theoretical tenets of the study, the skilled subjects revealed an awareness of *monitoring* strategies.

### 5.3.2.3. Skipping Difficult Sections (n)

A distinct strategy which apparently characterizes the novice readers in this study is the strategy of skipping difficult sections. As is clear from its title, the strategy was applied when the novice readers faced comprehension failure and decided to skip the problematic section in order to help comprehension of the rest of the text.

An example of the strategy is as follows:

| Text 1   | Protocol                           | Commentary   |
|--|------------------------------------|--|
| S16: They are therefore partly autotrophic and partly heterotrophic. | /I don't know 'partly'/ I skip it/ | <i>The strategy is applied when the subject fails to grasp the meaning of an unknown linguistic element be it a lexicon or a sentence.</i> |

However, research on identifying differences in strategy use between poor and skilled *first* language readers has shown that skilled readers too skip difficult sections. Olshavsky (1976-1977) presented students with stories to read, clause by clause, and instructed them to talk about what happened in the story and about what they were doing and thinking as they read. Good and poor readers were quite similar in their attempts to monitor comprehension; when they failed to

understand words or clauses, they used contextual cues, etc. In a second study, Olshavsky (1978) used the same procedure but varied the difficulty of the passages. Contrary to her predictions, strategy use decreased rather than increased with the difficulty of the passages, for both good and poor readers. Olshavsky attributed her unexpected results to the fact that students simply gave up trying to understand the difficult passages. What seems to be obvious in applying this strategy is the readers' failure in both bottom-up and top-down processing. A probable consequence of the skipping difficult sections strategy can be its negative impact on comprehension particularly where the skipped items constitute important elements in the text.

#### 5.3.2.4. Controlled Skipping (c)

A cognitive strategy used in Sarig's classification of strategies which reveals information about the monitoring behavior of the subjects is controlled skipping in which the subjects decide to ignore some sections in the hope that they will be clarified later by the following sections. An example of this strategy is as follows:

| Text 1  | Protocol   | Commentary  |
|---|--|---|
| S8: Whereas phagotrophic organisms take in solid and often living food, osmotrophic ones absorb or suck up liquid food. | /RRS/ 013/ I don't get this sentence/ now I continue the sentence/ perhaps I can get it by reading the rest of the sentence/ | <i>The subject clearly identifies unprocessed elements and asserts that this may be understood in the light of forward reading.</i> |



Half of the novice subjects used this strategy during task execution. This casts doubts on the studies which have claimed that lack of monitoring and evaluating for good comprehension characterizes poor readers (Ryan, 1981). The strategy may be the result of comprehension failure either at word (that is, watchers) or sentence level. Other studies in the field of *first* language between good and poor language readers have shown reading strategies similar to the one identified in this study in which the good readers reported skipping difficult sections and looking ahead in search of clarification (Baker, 1979). If this is the case, then one may assume that the novice readers in this study transferred their first language skills to solving comprehension problems in the second language.

Moreover, it seems plausible to assume that strategic decisions on skipping unresolved linguistic information appear to be dependent on two important factors: a threshold of foreign/second language knowledge necessary for text processing and a subject's knowledge about his/her memory capacity (Baker and Brown, op.cit.).

The role of language proficiency in successful text processing is well documented in second language reading research (e.g. Coady, 1979). The success of controlled skipping to a certain degree depends on having fewer comprehension problems or better language proficiency. That is, the higher the language proficiency, the

better the results of controlled skipping. The second important factor which is in a way a facet of language proficiency is one's ability to retain the previously skipped portions in mind in order to relate them to the next relevant information about the skipped elements. Novice readers due to slow processing of text information usually appear to forget what information they processed when they reach the end of a sentence. Sometimes, an increase in skipped elements may result in losing the total thread of comprehension. An example of this is as follows where NI1 skips a difficult sentence and the one coming after it in the hope of getting the meaning of the former.

## Text 2.

## Protocol

S2-3: In fact, among the larger and more complex plants and animals, death is the necessary consequence of ceasing to reproduce; when the individuals begin to grow old, the process cannot be stopped. It is possible that all organisms are like this, although most individuals do not die of old age but through accidents or disease, or because they are killed by other organisms.

*/in fact/ along larger and complex/ em/ the greater and larger combination of plants and animals/ I read it again/ in fact/ among/ along/ the larger and more complex plants and animals/ O2/ death/ death is/ death is the necessary consequence of ceasing to reproduce; when the individuals begin to grow old/ Oh my goodness/ LFV/ I read the next sentence/ it is possible/ perhaps it becomes clear in the next sentence/ it may be that these organisms/ it is possible that all organisms are not the same in terms of their stop / what does it mean / do not die of old age/ O.K. I go forward / it is possible/ no/ I went back/ LFV/ although most individuals/ personal / old age/ accident/ perhaps all have the same responsibility/ or/ O2/ diseases/ or killed by other organisms/ I think my understanding of the first part of the sentence is not consistent with this last part/ I must have made a mistake/ Oh / my goodness/ how terrible it is/ LFV/*



### 5.3.2.5. Paraphrasing (s)

In contrast to the novice readers' greater use of word for word translation in their text processing, this strategy was used most frequently by the skilled readers. The strategy is the result of the task requirements in which the readers were asked to report their thought processes and their understanding from the text. Obviously, the paraphrase strategy is a rewarding strategy which shows the reader's ability to state the meaning of a text in other words. However, its real processing value resides in identifying flaws in the readers' making paraphrase. An example of the strategy is shown below.

| Text 3  | Protocol   | Commentary   |
|---|--|--|
| S4: The idea was to learn about the general by studying the particular, to use a specific organism as a model for all others. | /05/ and/ um/ their general aim was to find a model organism that/ um/ an organism that can be used as a model for all others/ | <i>The strategy reflects the subject's attempt to provide an interpretation of the sentence.</i> |

Although SI6 presents an interpretation of the sentence, certain reading processes leading to its interpretation seem not to be available for verbalization. For example, in the above protocol there is no evidence showing the automatic construction of the sentence interpretation due to the generation of 'um' utterance implying hesitation and pause. It can be assumed that one possible reason can be attributed to the allocation of greater cognitive



resources for rendering a paraphrase of the sentence which causes SI6 not to report the intermediate processes. Therefore, due to the limitation of the workbench memory little space has been available for reporting the products of the paraphrase process (thus evidence for Britton, et al.'s ,1985 workbench memory model). It also justifies Ericson and Simon's (1993) assumption that cognitive processes do not attend in short term memory when the subject is under a high cognitive load. The strategy is the result of using all possible sources of information (that is, bottom-up and top-down) for interpreting a piece of text.

#### 5.3.2.6. Paraphrase With Deletion (s)

The strategy reveals subjects' attempt to disregard difficult sections in their paraphrasing. The reader may simply confuse this strategy with the skipping difficult sections reported in the previous section. The main difference between this strategy and skipping difficult sections is that the skilled subjects showed that they were actually paraphrasing linguistic information while in the case of the novice reader there is no report of paraphrasing and the subjects only reported skipping the difficult sections. An example of the strategy is as follows:

| Text 3  | Protocol  | Commentary                       |
|---|---|----------------------------------|
| S34: Darwin began <i>The Origin of Species</i> with | /08/ Now it explains what scientists chose /03/ for example | <i>The subject paraphrases a</i> |

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|   |   |   |
|---|---|---|
| <p>a discussion of artificial selection in pigeons- a good model because there are plenty of pigeons in England and the strains mimicked naturally occurring variation.</p> | <p>where Darwin began studying organisms/ it is giving a historical background as to who chose what /013/ then it says why Darwin chose pigeons/ cause there were plenty of them in England/ and / um/ variation is naturally high/</p> | <p><i>piece of linguistic information but deletes the section which appears to be difficult to interpret.</i></p> |
|---|---|---|

SI1 apparently disregards a full paraphrase of the last phrase of the sentence, that is, 'strains mimicked naturally occurring variation' and spells out only a partial interpretation of the phrase. It seems legitimate to hypothesize that SI1 did not understand the phrase but succeeded in understanding the general sense of the sentence, thus, decided not to paraphrase it. The /um/ verbal report at the end of his protocol marks his reluctance in disregarding the difficult section. Looking at the skilled readers' retrospection data, it was found that almost all occurrences of the strategy indicated the subjects' problems with the deleted sections in their paraphrases. However, the important notion of distinguishing important information from the trivia can still be expected in applying paraphrase with deletion.

Viewing the strategy from the interlanguage perspective, one may conclude that the strategy is a problem-avoidance strategy observed in spoken communication. The subject tries to do away with the problem, which is normally of a linguistic type, by changing his/her communicative goal. This

change of communicative goal is quite evident in S11's hesitating remark /um/ before the reduced paraphrased portion as shown above. Faerch and Kasper (1980) call this communicative strategy 'avoidance behaviour'. An implication which can be drawn from the above strategy is the application of spoken discourse strategies to written discourse with the purpose of tackling reading comprehension problems. It is also possible to speculate that such application may be the result of verbal interpretation of written discourse in which the subject interprets the text in a verbal or spoken manner.

The subjects seem to have compensated for their insufficient linguistic knowledge in paraphrasing portions of text by applying a spoken communicative strategy of reduction to either maintain fluency in written discourse or avoid making errors. The strategy seems, thus, to be extracted from the subjects' experience in verbal communication. Assuming that the transfer of verbal communication strategies to written communication has occurred, then one can reckon that such transfer has had disturbing effects on processing written communication. As regards the inter-rater judgement, one rater said that the strategy was an identification of cause and effect. However, we reached an agreement to call it paraphrase with deletion.

#### 5.3.2.7. Change in Reading Rate (c)

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A major point which needs explanation in regard to this particular monitoring strategy relates to the question of why change in reading rate was not considered as a main reading strategy in the identification and classification scheme. The answer resides in the technicalities which relate to the facilities which could reliably measure the exact reading rate. Since such facilities were not available to the researcher, it was decided not to include the strategy in the classification scheme to prevent subjective decisions. Furthermore, even if it was judged by other raters, the problem was to define what is meant by slow, normal and high reading rate. However, due to the importance of this strategy some remarks are in order.

Several subjects from both skilled and novice readers showed a change in their reading rates. An interesting finding in this regard is that subjects used this strategy for different purposes. For example, SI2 often read the text aloud at his first trial but upon facing complex linguistic information he slowed down the reading rate (c.f., Shiffrin and Schrenieder, 1977). This happened also for long sentences in which the reading rate was slowed down as he approached the end of the sentence probably as a result of an overload of workbench memory.

However, in the case of SI3 reading rate increased only after his first reading. Later on in his retrospection, he said that he did it because he was paying

attention to the words in his first trial. This initial identification of words caused him to increase the reading rate in his second trial.

NI2's controlled processing of difficult sections is clearly characterized by his slow reading rate. However, his reading rate increased with those sections that had already been reprocessed. NI7 also reduced her reading rate when facing a problem in processing some elements of the text. Looking at the reading rate from the perspective of compensatory interactive theory, it could be said that reading rate is more dependent on the speed with which a reader can recognize words and construct a representation, that is, on bottom-up skills than on the ability to use prediction.

#### 5.3.2.8. Monitoring Statements

Detecting problems in reading comprehension is an important aspect of revealing a reader's level of skill. It works in two ways: a) it allows the reader to identify his/her problems in understanding what is usually achieved by assigning strategies to solve the problem, b) it allows the teacher to identify types of problems and the level at which they are consciously detected by the reader and devise appropriate remedial instructions. Two main monitoring statements<sup>4</sup> were used by the 8 novice foreign language readers in their attempt to come to

grips with the reading comprehension task: identification of comprehension problem at word level (or icpwl) and identification of comprehension problem at sentence level (or icpsl). As can be seen in the figure below, the novice reader informants identified comprehension problems at word level more frequently (that is, 74%) than identifying comprehension problems at sentence level which contributed only 26% to the total proportion of monitoring statements. A description of the monitoring statements made by the reader informants of this study is as follows.

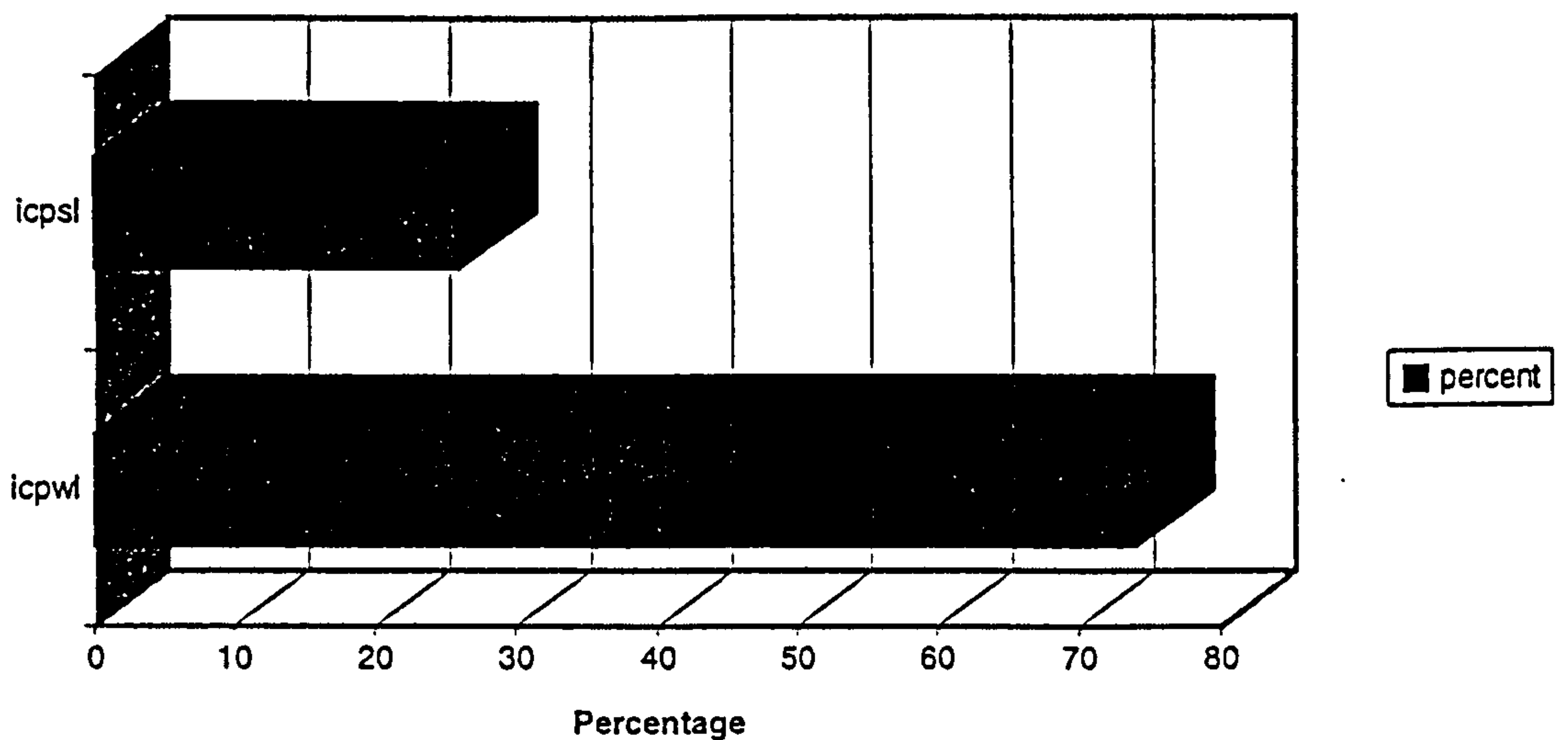


Figure 5.3. Proportion of monitoring statements made by the novice readers

#### 5.3.2.8.1. Word Level

<sup>4</sup> The term monitoring statement here refers to one's ability to detect his/her reading comprehension problems. Such monitoring statements fall within metacognition.



The statements made by the novice readers indicate the subjects having comprehension problems with items of vocabulary. An example of problem identification at word level together with its definition and the corresponding text is as follows:

| Text 2  | Protocol   | Commentary   |
|---|--|--|
| S1: When an organism stops reproducing, its own survival becomes unimportant. | /um/ my weakness is that /um/ that my range of vocabulary is low and I am dependent on dictionary/ | <i>The subject identifies his failure to comprehend due to his insufficient range of vocabulary.</i> |

As was previously indicated, it is generally noted in the related literature of reading research that a knowledge of one's cognition (including knowledge of weaknesses and capabilities as a language learner) is an important aspect of cognitive development (e.g. Baker and Brown, 1984; 1986). The importance of this knowledge is related to the preventive actions that one may take in order to anticipate or recover from problems. A reader who is not aware of his reading problem can hardly be expected to apply effective reading strategies to improve his reading weaknesses. For example, in the following, NI1 fails to deduce the meaning of the verb 'lack' due to failure to note logical rhetorical patterns present in S5 and S6 of T1. However, she appears cognizant of the causation rhetorical relationship in the third paragraph of T1 by saying:

/um/ I didn't get it/ however I reread it cause I think its reason must be important/.

This metacognitive awareness or reading with purpose helps her get the meaning of 'lack', an awareness that is absent in her first interaction with the verb 'lack'<sup>5</sup>.

Research into the use rhetorical structures in ESP by Selinker and Trimble<sup>6</sup> (1974 in Cohen, et al. 1979) shows that rhetorical or organizational decisions made by the author about a piece of prose is most often not apparent as such to the non-native reader, and therefore become hurdles to text processing among EST non-native readers. Sometimes the reason for comprehension problems at word level is attributed to pronunciation. For example, NI3 identifies her problem with a word as being due to a problem in pronouncing the word:

**/I pause on 'whereas'/ I don't know its pronunciation**

The slow reading approach to reading comprehension is implied in the monitoring statements of all other novice reader informants in this study. As to the number of subjects having word-related difficulties almost all the novice readers (i.e. 100%) testified that they had problems with words in the two reading comprehension texts (NI3 and NI4 having the highest proportion). The data display the need of the novice readers for interpretation of the texts. This need in fact has been identified in other ESP reading comprehension studies (e.g. Laufer and Sim, 1985) who found that the greatest need of their

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<sup>5</sup> See appendix B for a full transcription of NI1's think-aloud

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foreign language readers was for vocabulary 'since words appeared to be the safest and the most important landmarks in the search for meaning' (P:9). The novice readers' difficulty with words confirms the findings of cross-linguistic studies of reading of foreign and technical texts which highlight the important role that lexicon plays in EST text comprehension (Cohen et al. 1979; Ulijn, 1980; Albert-Dewolf, 1984; Mohammed and Swales, 1984)<sup>7</sup>.

However, the subjects' think-aloud data in this study showed that the great majority of their vocabulary problem is with the so-called *semi-technical* items. This is in symbiotic relationship with Cooper's findings (1984) and those of Strother and Ulijn (1987) in that both studies stress that for EST students, the lexical area should be focused on most, particularly the semi-technical vocabulary.

Apart from the inappropriate use of reading strategies discussed before, the tracking of the novice readers' comments on their strategies clearly shows the words that pose the highest reading comprehension problems to NI1, NI2, NI3, NI6, and NI7. Their main problem with items of vocabulary is with semi-technical ones such as 'possess', 'obtain', 'illustrate' etc. Baker (1988) reviews different attempts to define the term sub/semi-technical words. This study

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protocol.

<sup>6</sup> See chapter 2, section 2.1.3.



takes the definition that identifies semi-technical term as general language items which are used in preference to other semantically equivalent items, to describe or comment on technical processes and functions. For example, in biology textbooks, Baker asserts, the term 'happens' does not follow photosynthesis to describe processes, instead the term 'takes place' or 'occurs' is used. These last two verbs are categorized as semi-technical words.

#### 5.3.2.8.2. Sentence Level

A second monitoring statement reported by the novice reader informants is identification of comprehension problems at sentence level. An example of the statement is as follows:

| Text 1   | Protocol   | Commentary  |
|--|--|---|
| S15: However, all the green species are unable to synthesize at least one organic substance that they need, and they must obtain these substances osmotrophically. | RS/017/ when I face a long sentence like the one here /02/ I forget what it was all about/ um/ in my mind /02/ when I reach the end of sentence/ | <i>The subject identifies his/her failure to comprehend at sentence level due to length and other factors pertaining to integrating bits of sentence.</i> |

The protocol above clearly shows that the subject identifies his comprehension problems with larger linguistic chunks, that is, long sentences. Many factors could reasonably be counted for the problems. One being the slow pace of reading among the novice readers. In addition to problems with words, if syntax

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<sup>7</sup> See chapter 2, section 2.1.4.

appears to be problematic to the reader then it would be possible to imagine that the scale of the problem would result in an overload of short term memory. That is, by the time the reader reaches the end of the sentence s/he had already lost what the sentence was all about.

However, in contrast to their over-reliance on identifying comprehension problems at word level, for the novice reader the structure including syntax and discourse seems to play a less important role inasmuch as when the key words of a sentence are not known, awareness of syntactic structure can be of little help.

The identification of comprehension problems with chunks larger than words is normally expected to happen among skilled foreign language readers, nevertheless such an awareness at the level of novice readers provides counter evidence to the prevalent theory of novice reading strategy in which novice readers are described as being preoccupied with word strategies. In fact, within an interactive theory of reading comprehension, a poor reader is expected to rely on both lower-level and higher-level processing but at times the reader tends to rely more on higher-level than lower-level of processing due to deficiency in lower-level processing (see compensatory interactive theory of reading reported earlier in chapter three).



In contrast to the proportion of the monitoring statements made by the novice readers, 76% of the total 88 number of occurrences of problem identification made by the skilled readers belongs to problem identification at sentence level (see figure 5.4. below), while only 24% of the problem identification is related to the problems at word level. The data above clearly show that the skilled subjects' main monitoring processing is reflected in larger chunks of language. A main cause for this is most probably the skilled readers' automatic processing of words which frees capacity for the readers for further processing of text.

As for these monitoring statements, representative samples together with their commentaries were presented and accounted for earlier in this section. Therefore, in order to avoid repetition they will not be exemplified in this part.

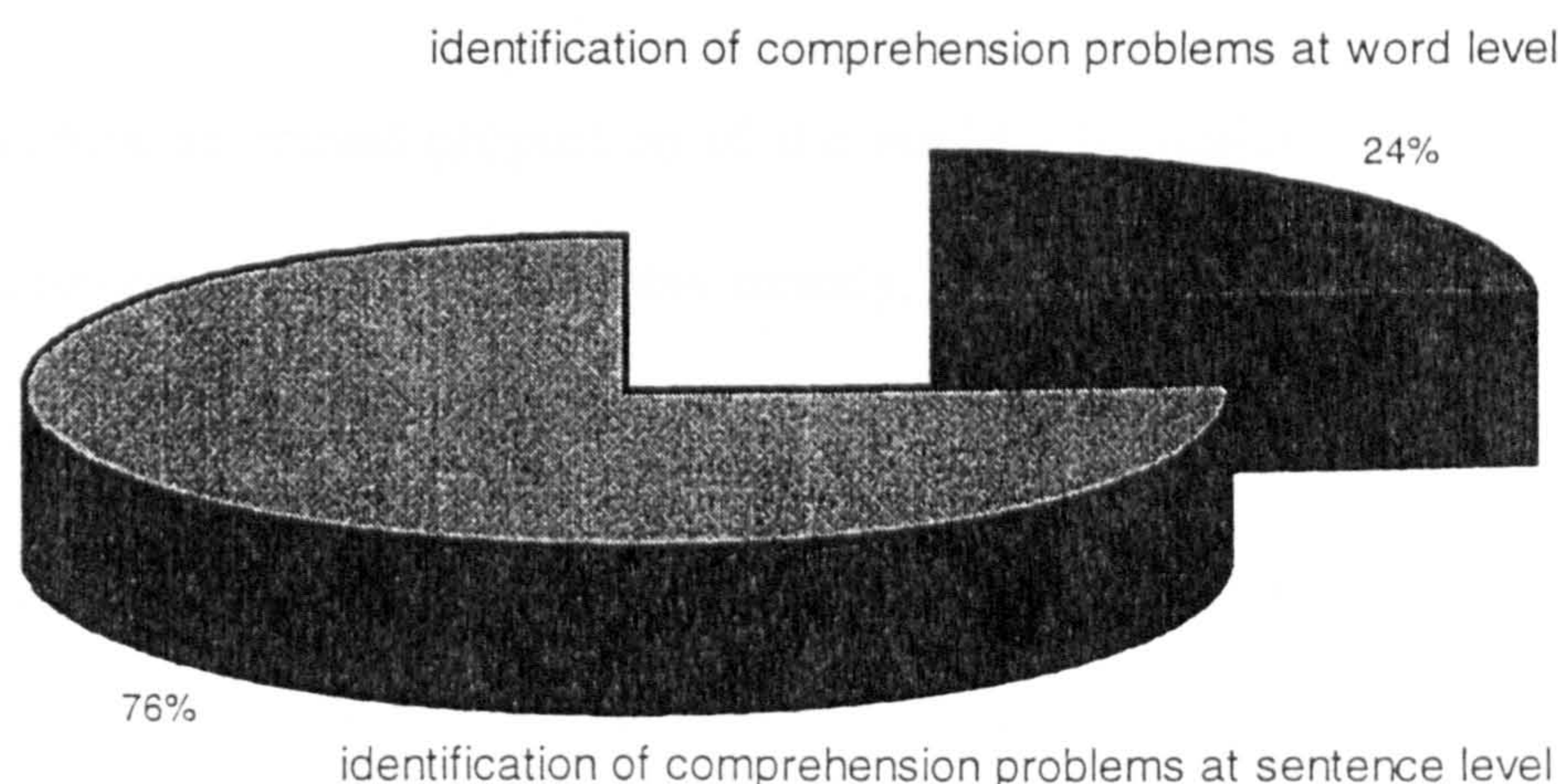


Figure 5.4. Proportion of monitoring statements made by the skilled readers.



The identification of comprehension problems is all shown to be the result of *conscious* processing of the texts. Although the readers' awareness was oriented differently, problem identification is said to be prerequisite for taking action in order to solve comprehension problems. Furthermore, as the above protocol shows, the novice reader informants have not developed automatic skills of word identification. The slow processing characterizes poor readers in general. This in turn, triggers an overload of short term memory which due to its limited capacity does not allow the subject to keep all the previously processed data in mind, hence results in losing the thread. However, readers in the course of monitoring their strategies, resort to remedial strategies. In other words, realizing that one has failed to understand is only part of comprehension monitoring; one must also know what strategies to use to solve such failures in comprehension.

This section examined proportion of the reading strategies. Two main higher-order categories of reading process mainly, prior knowledge and metacognition were examined. Using background knowledge and predictive recognition of text development were discussed as two prior knowledge text processing. A greater variety of strategies belongs to metacognition component of the reading process. Skipping trivial section is a metacognitive strategy used by the skilled readers in their attempt to make use of the memory resources and to disregard the

unimportant information. The novice readers, on the other hand, resorts to skipping difficult section to maintain minimal understanding of the text. Another important monitoring strategy showing subjects' control over reading is controlled skipping. Self interrogation is another attempt on the part of the skilled and novice readers to exert control on comprehension. Reading rate indicates that an executive/metacognitive force is at work. Ignoring difficult sections in the skilled readers' paraphrase strategy indicates also the skilled readers' control over text processing. The results of the readers' monitoring statements showed that, as is evidenced in the EST literature, the novice readers are handicaped with semi-technical words and are in need of better word-related skills.

### 5.3.3. Inferencing

#### 5.3.3.1. Reprocessing to Get the Gist (c)

The strategy is evidently an attempt on the part of the novice and skilled readers to tackle comprehension problems caused by failure in getting the gist of a sentence.

An example of the strategy is as follows:

| Text 1.  | Protocol  | Commentary   |
|--|---|--|
| S7: Among these 'other-feeders', or heterotrophs, we distinguish between 'solid-feeders', or phagotrophs, and 'liquid-feeders', or osmotrophs. | /I didn't get the gist of the sentence/<br>I reread it/ | <i>The strategy is mainly applied when the subject does not grasp the gist of the sentence and therefore resorts to reprocessing which is accompanied by various acts of backtracking within the sentence too.</i> |

The strategy is also one of the most frequently used strategies by the novice readers and shows their awareness of the need to search for meaning in the text.

The strategy nevertheless provides counter evidence to Brown, et al.'s (op.cit.)

contention that poor learners are not always aware that they must attempt to make

sense of the text and look for meaning. The protocols of the novice readers

showed that they had problems in rendering a correct construction of the gist of

the text. An implication of this can probably be attributed to some factors. One

important reason might be the fact that the readers were not able to distinguish

important information from the trivia and thus give the same weight to all elements

of the text. A second reason can be related to their overwhelming application of



word-related strategies wherein problems with words might deter them to get the gist.

Another implication relates to the frequent occurrence of the strategy among the skilled readers who employed this strategy as the second top frequent strategy in their approach to reading for meaning. This implies that the skilled readers, apart from automatic processing of word identification, were originally engaged in getting the essence of the text, a strategy which is highly needed to be taught to the novice readers.

Obviously, the attempt made by both novice and skilled readers in constructing gist of the text reflects their desire to resort to higher order processes at discourse level too. How different components of text lead the readers to make a discourse representation is something which needs further research. What is known is that reprocessing to get the gist is one way of tackling the problem.

### 5.3.3.2. Reprocessing Long Structures (c)

Partly related to reprocessing to assemble (see section 5.3.3.3.) is the strategy of reprocessing long structures. The strategy exhibits the novice readers' problems with long syntactic structures. An example of reprocessing long structures is as follows:

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| Text 1   | Protocol                                       | Commentary   |
|--|--|--|
| S7: Among these 'other-feeders', or heterotrophs, we distinguish between 'solid-feeders' or phagotrophs, and 'liquid-feeders' or osmotrophs. | I must reread it/ cause it is a long sentence/ | <i>The strategy shows the subject's attempt to reprocess a sentence which s/he identifies as long.</i> |

Length of chunks therefore, poses problems to poor reading comprehenders. The problem obviously resides in the processing capability required from the novice reader to encode both meaning and structure. Two important interdependent factors can be attributed to the application of the strategy. One reason might reside in the readers' pre-occupation with slow word for word approach to text comprehension. While within the interactive approach proposed in this study it is quite natural to expect words to be processed by the readers, one would expect that slow processing of word or word identification affects comprehension of longer pieces of text. To overcome the problem the reader is pushed to reprocess the structure. The second reason that seems to be the consequence of slow word for word reading draws upon readers' memory capacity which does not allow the readers to keep longer strings of items of language in mind. Due to the limited capacity of the STM, and the relative allocation of attention to processing items of language one by one, the reader is obliged to reprocess the longer unit of meaning. Due to familiarity with the items of language processed in the first trial, the reader can exert better control on the text. That is why a second reading is usually accompanied by higher reading rate.

Obviously, the reprocessing strategy itself is not an inefficient strategy because it is one of the important ways available to the readers to recover from the inefficient slow pace of word by word bottom-up processing. The readers' choice of strategy, in this regard, is worth noticing in that it provides counter-evidence to what Paris and Meyer (1981 in Brown, et al., op.cit.) call novice readers' inappropriate use of reading strategies when they encounter comprehension problems.

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For the skilled readers the strategy was among the fewest-frequently used ones (that is, F: 7). The use of this strategy by the skilled readers might be due to relating different portions of a long sentence to each other to form a coherent picture of the sentence. The following excerpts are taken from SI6's verbalization<sup>8</sup> who justifies his choice of reprocessing longer strings of linguistic elements in the text.

[(reads S12 in RS mode)]/ 023/ ok/ cause the sentence is long/ I dissect the sentence and discuss each section separately to relate them together/

[(reads S27 in RS mode)]/ 010/ em/ 05/ I need to read it again to translate the sentence to you/ this is because I want to recall what I read/ I usually do this particularly with long sentences/

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<sup>8</sup> See appendix B for a full transcription of SI6's protocol data.



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/its translation was a bit difficult/ 04/ but in this paragraph in spite of a long sentence/ I mean S34/ I could easily understand it/ cause only one subject was targeted for discussion/

[(reads S47 in RS mode)]/ 012/ um/ 06/ I read this sentence again cause I want to relate what is in the parenthesis to the rest of the sentence or at least separate it from the sentence to be able to interpret the sentence/

:

[(reads S64 in RS mode)]/ 015/ I read the sentence again cause it was a long sentence/ 08/ to translate the sentence I read it bit by bit cause I couldn't get the sentence/

As can be seen, both task requirements as well as relating different parts of a long sentence are the main causes of SI6's reprocessing strategy. Later in his retrospective comments in response to the question whether he actually reprocessed to *translate*, he added that he did it since he wanted to present a *paraphrase* of the sentence and not to translate in its strictest sense. Like novice readers of this study, the skilled readers also resorted to processing longer stretches of text. To reprocess strings of words and to make a meaning representation requires one to employ an intricate interactive process in which many elements from lexicon, syntax and semantics come to play a role in forming such a representation.

### 5.3.3.3. Reprocessing to Assemble (n)

This strategy used by the novice readers of this study requires the readers to reprocess a sentence or part of a sentence for the purpose of getting the meaning of a word or of a sentence to form a general picture of the sentence. The strategy is backtracking to assemble. An example of the strategy taken from the protocol excerpt of NI6 is as follows:

| Text 1  | Protocol   | Commentary   |
|---|--|--|
| S1: Plants characteristically synthesize complex organic substances from simple inorganic raw materials | RS/ 012/ although each word is known to me yet I don't have a general view and I need to assemble them in my mind/ 02/ to get a general view/ I read it again/ | <i>The strategy shows the subject's failure in assembling the individual words and requires him to reprocess the sentence to get a general view.</i> |

One probable reason why the subject here is not able to draw a general picture of what the sentence is all about might partially be due to the habit of word for word translation from foreign language to first language. In this regard, somewhere in his reaction to his failure with S2 of T2, NI8 says:

'/My habit in writing [(he means translation from foreign language to his first language)] is jotting down all the words/ 01/ it is only then that I may fully understand the sentence/.

However, the data obtained from NI6's protocol show that he halted to read a sentence in which he identified an unfamiliar word thus monitoring his comprehension. This was accompanied by a backtracking to the very beginning of the sentence which occurred 8 times in the subject's total reprocessing to assemble, hence depriving himself from making full use of the rest of the sentence.

Obviously, despite the merits of the reprocessing to assemble strategy that shows the subjects' understanding of the need to tackle comprehension problems, the protocols of the novice readers show that they had problems in getting meaning as a result of employing the strategy. We may assume that one reason for this might relate to their inadequate syntactic knowledge. The above protocol shows that identification of words is not the whole story. Clearly understanding text is more than understanding the component words, other processes (such as a sound syntactic knowledge) are needed that take the meanings of the words, together with their order in the stream of text, to form a more global meaning.

This strategy has some relationship with another strategy, that is, reprocessing to get the gist mentioned earlier in this section. The only difference between the two resides in the fact that in the case of rereading to get the gist the cause of the problem is not mentioned in the protocol and therefore leaves one wondering as to the origin of the comprehension problem (the probable sources of comprehension

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problems in the case of getting the gist can range from structural to lexical and rhetorical problems). In the case of the reprocessing to assemble strategy, on the contrary, the subjects explicitly specify the source of the problem.

#### 5.3.3.4. Reprocessing to Get Word Meaning (c)

The strategy shows the novice and skilled readers' attempt to understand an unknown lexical item by rereading the sentence in which it occurs. An example of the strategy is given below:

| Text 1  | Protocol   | Commentary  |
|---|--|---|
| S5: Animals, on the other hand, must obtain complex organic substances by eating plants or other animals. | /02/ ok/ 'obtain' is not known to me/ I reread the sentence from the very beginning/ | <i>This strategy is an attempt to get the meaning of an unfamiliar lexical item by rereading the sentence in which the lexical item occurs.</i> |

As table 5.1.1. shows, this strategy is used extensively (that is, with a frequency of occurrence of 43) by all novice subject informants. After repeating to get word meaning and word for word translation, this strategy occupies the third most frequent novice reading strategy in the frequency table. An important feature of the strategy is the fact that it is the only strategy that is used by all novice subjects. As the above protocol shows, the strategy obviously shows subjects' control of comprehension failure. This provides counter evidence for Brown et al. (op.cit.) contention that novice readers do not have the necessary understanding of the

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reading process to control their own activities. The strategy is the one that is, according to the relevant literature, applied by skilled language readers who use context as much as possible in solving word problems. Other language reading research studies have confirmed the occurrence of the strategy among skilled readers. For example, Baker and Anderson (1982 cited in Brown et al., op.cit.) report that college students frequently look back at sentences that are inconsistent with subsequent information. The skilled readers in this study found some words difficult to understand. They too tried to reprocess the sentence in which the problematic word occurred. However, as the protocols show, they failed probably because of lack of strong prior context and/or decoding ability.

Viewing the strategy from the perspective of Stanovich's (1980) interactive compensatory model one would find evidence showing that poor readers often compensate their low-level processing abilities with more reliance on contextual features.

#### **5.3.3.5. Highlighting for Reprocessing (s)**

Highlighting for reprocessing is a skilled reading strategy not shown by the novice readers. As its name indicates, the strategy is basically used for those sections that subjects find important for later reprocessing. An example of the strategy is as follows:

| Text 3  | Protocol  | Commentary   |
|---|---|--|
| <p>S82: The wide distribution of these genes suggests that they may affect the identity of floral organs in all angiosperms; they may thus provide a new tool with which to address the origin of the angiosperm flower form its gymnospermous ancestors.</p> | <p>/I read the last sentence of the paragraph/ I suddenly decided to highlight it/ I am doing this to look at them for my second rereading/</p> | <p><i>The strategy shows the subject's decision to highlight parts of the text which s/he thinks important for future rereading.</i></p> |

Attribution of importance is quite revealing in the above protocol and it is this understanding of the important section/s which causes SI5 to plan to highlight the last sentence of the paragraph for the purpose of reprocessing. According to Wenden (1985) students may test their needs and preferences and select what they want to learn and how they should learn a language. Regarding this, SI5 apparently chose to use highlighting as one of the best techniques to reprocess important sections. He has given priority to aspects of the text he wants to learn. By choosing and prioritising, he sets his own learning-from-the-text goals.

Discussing study strategies, or reading for remembering as well as understanding, Brown et al. exemplify highlighting as a helpful strategy for understanding and remembering in text comprehension. In this regard, Fowler and Baker (1974 cited in Brown et al., op.cit.) found that college students who highlighted their texts recalled more of the material they marked than did



students who received a pre-marked text. Highlighting in S15's think-aloud data has got an important status and is mostly utilized, as is evident in his assertions, for the purpose of reprocessing. However, he used this strategy for other purposes as well. For example, in his reaction to S26 of T3 when he highlights the word, 'diversification' he says:

*/I highlight this to consult it with dictionary later for myself/*

#### 5.3.3.6. Inferencing (c)

Like reprocessing to get word meaning, an inferencing strategy used by both the novice and skilled readers makes use of contextual information surrounding an unfamiliar linguistic element. The difference between inferencing and reprocessing to get word meaning is that, in the case of the latter, subjects did not report on whether reprocessing was successful, while in the case of inferencing, subjects pointed to how inferencing occurred. An example of the strategy is as follows:

| Text 1  | Protocol  | Commentary  |
|---|---|---|
| S12: The reason for this is that many plants lack chlorophyll and feed heterotrophically, and some animals possess it and feed autotrophically. | <i>/RS/ 08/ here again we have 'lack'/ 01/ which is not clear to me/ I need to read the sentence again/ 011/ I think it means not having /01/ I inferred it from 'heterotrophically'/ that the plants which do not have chlorophyll feed heterotrophically/</i> | <i>The strategy shows the subject's effort to infer the meaning of an unfamiliar linguistic element from the context.</i> |

The occurrence of the strategy goes counter to the notion that asserts that novice readers do not use the advanced strategies of proficient readers. Wenden, for example, claims that 'ineffective learners are inactive learners' and that 'their apparent inability to learn is, in fact, due to their not having an appropriate repertoire of learning strategies' (P:7). However, in a recent case study of four novice and advanced foreign language subjects, Van and Abraham (1990) found that their unsuccessful learners were not necessarily inactive or lacking in their repertoire of strategies. This finding is confirmed by the use of the inferencing strategy in this study. The novice readers' use of the strategy suggests that such readers do have access to the inferencing strategy in their strategy repertoire. As for the skilled readers, the strategy was used 15 times across their text processing.

#### 5.3.3.7. Watchers (n)

An example of the subjects' resorting to a contextually-related technique that assists comprehension of unknown words is employing 'watchers' technique that was first identified in story reading research. Using 'watchers' technique, N11 recalled certain unknown words remaining in her mind to show that she was still in search of information which she hoped would shed light on the meaning of the unknown words. Below is an example of the behavior:

| Text 2                                       | Protocol   | Commentary  |
|--|--|---|
| S14: The importance of variation individuals | /this is the same adaptation which was earlier used in the | <i>The reader activates certain elements called 'watchers' in his/her mind, which</i> |

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species means, in the short description of remain active until a term, that some are better 'meiosis'/ I still want particular kind of required adapted than others. to know what it information is received.  
means/

Anderson (1980 cited in Baker and Brown, 1984) describes this technique as the ability to store a comprehension problem in memory as a pending question in the hope that the author will soon provide clarification. The technique reveals subjects' awareness about their memory capacity. The relevant literature on metacognition establishes that an effective reader has a fair awareness about his/her own characteristics including his/her memory capacity (Brown, et al., op.cit.). An effective reader, accordingly, is the one who does not keep a lot of unresolved questions in mind and avoids overburdening his/her memory by keeping too many pending questions, too many unknown words and abstract phrases. The performance of the novice readers in this study showed that they kept one unknown lexical item in their memory to be resolved later. The strategy shows the readers' attempt to use context as a top-down strategic move to assist comprehension. Within an interactive theory, poor readers too resort to contextual information to compensate for deficiencies at lower level of text processing.

#### 5.3.3.8. Identification of Comparison/Contrast Structures (s)

As its name indicates, the strategy is an identification of high level structures in the text. Below is an example of the strategy:



| Text 3   | Protocol   | Commentary  |
|--|--|---|
| S72: Because of such differences in approach, experimental scientists and phylogeneticists have tended not to understand the underlying questions of each other's disciplines, much less to delve deeply into the details of the literature. | /20/ it points out to the difference between these two/ 09/ their approach is different/ | <i>The subject recognizes the comparison and contrast structure of the information in the text.</i> |

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SI2 refers to the rhetorical structure of the information. Such a recognition helps readers get the gist of text. The strategy, on the other hand, is also a clarification move via simplification of the information in the text. Processing the text automatically after 20 seconds, the reader recognizes high level structures of the text. Apart from the reader's knowledge about the rhetorical organisation of the text another kind of knowledge is required for a reader in a successful text comprehension and that is sensitivity to importance. As important as knowledge about text structures is the reader's ability to distinguish central ideas from those which are peripheral (Osmanson, 1979, cited in Baker and Brown, 1984). The protocol shows that the subject has a good understanding of distinguishing important ideas in the text.

### 5.3.3.9. Repeating to Get Word Meaning (c)

This word-related strategy revealed in the verbal reports of both the novice and skilled readers is repeating to get word meaning from LTM. The following is an example of this strategy:

| Text 1  | Protocol                               | Commentary   |
|---|--|--|
| S7: Among these 'other-feeders' or heterotrophs, we distinguish between 'solid-feeders' or phagotrophs, and 'liquid-feeders' or osmotrophs. | /RS/<br>'osmotroph'↗/<br>'osmotroph'↘/ | 016/ <i>The strategy shows subject's attempt to retrieve an unknown word from his/her long term memory by repeating it that is often accompanied by a rising/falling intonation.</i> |

This strategy has the highest frequency of occurrence (that is, F:90) and is used by the majority (i.e. 75%) of the novice readers. The readers attempt to find the meaning of the unknown word by repeating it in the hope that they can find a match in LTM and can therefore retrieve it. The novice readers' high frequency of use of this strategy draws upon the fact that the novice readers were involved in word retrieval strategy without turning to other contextual information which may provide them with appropriate clues. One important key signaling device in the text above is the immediate available synonym for the word 'osmotroph', that is, 'liquid-feeders'. The importance of such signaling devices in discourse comprehension is elaborated by Hoey (1983; P:109) who argues for the search of repetition in text. Ryan (op.cit.) argues that poor readers are sometimes less sensitive to the relative importance of information units within a passage.

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Furthermore, over-reliance on word retrieval strategy might lead the reader not to eliminate other unlikely alternatives that come to attention when the act of retrieval is executed. Such a strategy not only may make reading comprehension laborious but might result in dramatic comprehension failure. Despite the high frequency of the strategy, which directly represents the readers' over-reliance (enormous in the case of novice readers) on the strategy as the best means of tackling comprehension problems, the protocols show that they had problems in retrieving the required information. The strategy is in some cases shown as a mere act of over-repeating. An instance is NI2 who sometimes over-repeated to retrieve word meaning. Such over-repeating is targeted towards those words which he recognizes as key words. This is quite evident in the case of the word 'survival' in S1 of T2 and 'exchange' in S12 of T2 where he repeats them five to six times in the hope of retrieving them.

Compared to all other strategies, this strategy seems to be dependent on both memory and language proficiency. That is, to be a successful word retriever one has to have a good memory and have ready access to LTM. One way to achieve this seems to be through a knowledge of word inflection and derivation that may be of great help in tackling word recognition. Novice readers due to lower language proficiency (or lower range of vocabulary knowledge) are more disadvantaged in retrieving word meaning from LTM than the skilled readers. The



skilled readers, on the other hand, used the strategy only 27 times. An instance of this is SI2's verbalization<sup>9</sup> of S22 where he repeats 'lagged' twice in the hope to retrieve it from LTM. Leaving the problematic part aside and reading the rest of the sentence increases his engagement in text processing to the extent that at the end of the verbalization he admits the problem.

## Text 3

## Protocol

S22: In most cases, the systematics has lagged far behind the bench work; for several species (e.g. *Arabidopsis thaliana*), the phylogeny is so rudimentary that no clear direction for comparative studies can be provided at this time.

/S22: 'in most cases'/ WFWT/ 'the systematics has lagged<sup>7</sup>'/ 'lagged<sup>8</sup>'/ I don't know this word/ 02/ 'far behind the bench work'/ in many cases the systematics/ the basis of their work relates to/ that is depends on laboratory work/ 'for several species'/WFWT/ 'arabidopsis'/ it is the scientific name of a cabbage/ ....MT..../ 'the phylogeny is so rudimentary that no clear direction for comparative studies can be provided at this time'/ for plants/ em/ the 'phylogeny'/ again I think it refers to the same quick change/ whatever it might be/ changes are inevitably genetic/ 03/ it is not quite known that we can compare them/ em/ 03/ other organisms/ em/ however/ we cannot make full use of it at the moment/ what nonsense interpretation I am making out of the sentence/ LFV/

To sum up, the strategies discussed so far show that both readers of the two groups used a handful of higher order strategies in their struggle to process the text. An example of using higher-level processing for inferencing meaning of an unknown item of vocabulary is the use of the watchers strategy used by the novice readers in this study. Another important strategy used by almost all novice readers is the strategy of reprocessing to get word meaning. The strategy shows subjects' resort

<sup>9</sup> See appendix B for a full think aloud report of SI2.

to information provided in the text to infer the meaning of an unknown lexical item. Another strategy which required the reader to infer the meaning of different pieces of the text is reprocessing to assemble. The information is drawn from the context as the reader processes all the surrounding information such as lexicon and syntax. Closely related to reprocessing to assemble is the strategy of reprocessing to get the gist. The need to resort to all information to make a meaning representation of the text is the main purpose of employing this strategy. Reprocessing long structures is another example of subjects' attempts to make text representation by bringing all pieces of information in the text together. Repeating to get word meaning is an example of relying on guessing and resorting to memory to tackle problems in comprehension. And finally by finding clues in the text, the skilled readers infer a high level structure in the text, that is, comparison/contrast structures.

#### ***5.3.4. Discourse processing***

##### **5.3.4.1. Main Idea Construction (s)**

This strategy reflects an attempt to achieve the essence of reading comprehension. The construction of the main idea was usually observed to happen at the end of each paragraph and is clearly a sign of a relatively late developing skill in most skilled readers. An example of the strategy is as follows:

| Text 3   | Protocol  | Commentary   |
|--|---|--|
| ¶ 1. [(After finishing paragraph 1, SI6 makes the following main idea.)] | /035/ Um/ the main idea of the paragraph is that they have used certain organisms as models in order to determine other models/ | <i>The subject based on the important points in the paragraph constructs a main idea to enhance comprehension of the text.</i> |

In constructing the main idea of the text, both bottom-up and top-down knowledge are at work in such a way that it more often makes the construction process automatic, hence making the intermediate and generating processes unavailable to be verbalized in STM, evidence for Ericson and Simon's (1984; 1993) verbalization model. This is in fact in accord with Shiffrin and Schneider's (1977) contention which asserts that well-practised activities tend to become automated. Instructionally, however, such automatic processes not available to verbalization are less than helpful. One way to solve the dilemma is to present absolutely unfamiliar and difficult reading material to skilled readers, so that problems become more difficult to solve, and more intermediate products become available in STM, hence verbalizable.

In the three instances of his main idea construction strategy, SI2 heavily relied on the last few sentences of a paragraph that existed in his short term memory. An example of this is the subject's attempt to construct the main idea for paragraph 10 in which the main idea of the paragraph is an explanation of the limitations of the



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approach. This suggests a generalization of a model system based on commonalities. He says:

**/the main idea of the paragraph is that it first makes a question that whether the frog can really be used as a model for the systematics/ for all others/ and then it says about its characteristics/ that it can be a weak model for the biomechanics of feeding/**

Reliance on the last few sentences of the text is:one aspect of less than perfect performance in the literature of main idea construction that has to be systematically investigated. What seems to be interesting about this is the subject's conception about his memory capacity and the construction of a main idea. The subject's attempt to construct main idea seems to be more influenced by his awareness about his processing capacity than the real requirements of the task of main idea construction. Obviously, a successful approach to main idea construction is to keep all important elements of a paragraph in mind. This could be done by highlighting them and by a quick review to make a list of all the important elements.

In spite of lack of evidence in his verbalization of the data about whether SI3 got the text by a reprocessing strategy, he clearly identified the high level structure of the text in his retrospective explanation about the main idea of the text:

*/ It has compared two different views/ a view which relies on experiment/ and a view that /03/ is connected to the outside/ it has compared these two views as to how they can avail themselves/ do they accept each other?/ to get a kingdom/ and one from each family of each group can help/ 02/ generalizing it to other/02/ organisms of that group/ can we generalize to a whole by comparing one organism or an animal?/ it has finally pointed out to the differences between the views and their vocabularies/*

His retrospective explanation of the main idea of the text reveals an effort to list and collect all important information from the text. Such a listing does not obviously reflect a mere top-down strategy in which graphic cues are selected by the reader but is a case of picking up important information from the text in a reprocessing manner in order to make a text representation which reflects the subject's attribution of importance to parts of the text rather than making use of redundancy in the text for making hypotheses. This listing strategy is in accord to Afflerbach's (1990) findings in which listing strategy was found to be used by the skilled native speakers of English.

#### 5.3.4.2. Relating (s)

In this strategy the skilled subjects relate parts of the text to each other. The following is an example of the strategy:

| Text 3  | Protocol  | Commentary   |
|---|---|--|
| S9: In systematics, by contrast, a relatively small group of scientists studies a very large number of organisms. | <i>/I read the second paragraph and relate it to the first paragraph/</i> | <i>The subject cross-references or relates parts of the text to one another to detect coherence.</i> |

As is shown in the protocol above, SI5 attempts to relate two paragraphs to detect coherence in the text. This is obviously a top-down strategy in which the reader looks at the overall picture of the two paragraphs. The strategy also shows the reader's selective attention in which he focuses on certain linguistic information (that is, paragraph) to detect coherence. The joining of the two paragraphs into one signifies the subject's awareness of his memory capacity as well. In order to avoid keeping too many linguistic items in memory, a mature reader tries to make text more meaningful by trying to fit and relate the new material to the previous material. This strategy helps readers gain much from the text by not over-burdening their memories.

In short, strategies coming under discourse processing show the skilled readers' involvement in global level of text processing. An example of such a global processing strategy is main idea construction. Although in such a processing both top-down and bottom-up processing are at work, the focus is on the fact that main idea construction relates to maintaining a global view of the text. Another example of global processing of the text is relating wherein the subjects try to relate pieces of text to attain global processing.



### 5.3.5. Word Recognition

#### 5.3.5.1. L1-equivalent Search (c)

L1-equivalent search is another word-related strategy employed by both the novice and skilled readers. As its name indicates, the strategy is an attempt to select from among a series of first language alternatives the best alternative to serve as a language equivalent for an L2 word. The strategy is basically applied when the novice reader chooses to have recourse to translation to solve a vocabulary gap, therefore, compares the alternatives and chooses the one which he deems most suitable for the target language text. The strategy seems to originate from the novice subjects' habit of translation and of finding an equivalent synonym for an unknown word in a word for word manner of approaching a sentence. An example of the strategy is as follows:

| Text 1  | Protocol   | Commentary  |
|---|--|---|
| S13: The problem is well-illustrated by the various species of protozoans that are grouped together in the genus <i>Euglena</i> . | /and / um/ 'illustrate'/ or well-expressed/ well-designed/ what can I say/ well-explained/ | <i>The subject searches to find a suitable first language equivalent for an item of language/</i> |

The strategy is a 'potential equivalent retrieval strategy', to use Krings' (1987, P: 169) term, and is an evident sign of confusion in task requirements by the two novice readers of the study (i.e. NI5 and NI7).

Within the theoretical framework of this study, the application of L1-equivalent search by the novice and skilled readers reflects their attempts at word recognition level, where they try to find a synonym for the problematic item. The comparison reveals an important aspect of strategy use. That is, the overall picture of using the strategy shows that while common strategies were used by both skilled and novice readers in tackling comprehension problems, such strategies were found to be used for different processing purposes. That is, while the novice readers used the strategy for the purpose of word for word translation the skilled readers resorted to it to overcome a vocabulary gap for the purpose of paraphrasing.

The use of this strategy by the novice readers may be partly due to their extensive use of word for word translation in reading comprehension and to their instructional background (that is, translation exercises required by the language teacher as part of the EST course requirements) which has created in them a better access to list/s of first language equivalent options in their LTM. However, thinking in the first language while processing a text in a second language, albeit to some extent a natural process in learners' early interlanguage development, can be detrimental to the totality of reading comprehension (see the comments on word for word translation, section 5.3.5.3.). We can also assume that using L1-equivalent search can be the result of requiring the readers to verbalize their

thought processes in the first language where the reader tries to find an appropriate vocabulary in L1 for expressing an item of vocabulary in L2.

### 5.3.5.2. Decoding (n)

A common well characterized and generally well documented strategy in reading comprehension is decoding. Readers due to problems in identifying unfamiliar or difficult words usually process them slowly by breaking them into syllables in order to form meaning representations in their mind. This is usually exemplified in a slow and laborious word for word bottom-up approach to reading. The following is an example of decoding strategy:

| Text 1   | Protocol   | Commentary  |
|--|--|---|
| S15: However, all the green species are unable to synthesize at least one organic substance that they need, and they must obtain these substances osmotrophically. | /that they need to get the <u>substances</u> /'osmotrophically'/ 'osmotrophically/ | <i>The strategy is an attempt to tackle the meaning of an unknown lexical item by a rather slow reading rate characterized by breaking it down into syllables. It is sometimes accompanied by repetition.</i> |

Needless to say, the decoding strategy is an important aspect of text processing. While decoding is not an important issue in most top-down models due to their emphasis on relying on contextual print, such a strategy is given importance within interactive models. ESL poor readers and sometimes even skilled readers due to



their poor knowledge of vocabulary often need to resort to decoding strategy in order to recognize an unknown or less-frequently used lexical items.

### 5.3.5.3. Word for Word Translation (n)

The technique or the habit of word for word translation is extensively utilized by the novice readers (F:73). Going through a laborious stage of reading word for word and occasionally phrase by phrase, the subjects translate a given sentence.

An example of the technique is as follows:

| Text 1   | Protocol   | Commentary  |
|--|--|---|
| S3: The plants can use this energy because they possess the green pigment chlorophyll. | /'the plants can use'/ wfw/ 'this energy'/ wfw/ 'because'/ wfw/ 'they possess'/ wfw/ 'chlorophyll'/ wfw/ | <i>The technique reveals the subject's attempt to understand the meaning of the sentence by breaking it down into phrasal units and applying translation.</i> |

This strategy also reveals the subjects' involvement in an approach which could be an artificial by-product of the verbalization task which required the subjects to give an interpretation of each sentence processed. The only study, to the knowledge of the present researcher, which has given an account of this technique through concurrent verbal report protocol analysis is the pioneering study of Hosenfeld (1977). She observed that her deficient foreign language readers applied translation from target language to their first language. However, due to laborious word for word translation of the reading task, it is not recommended on

the following grounds: a) it demands greater space in short term memory to keep all the previously processed data for a second reprocessing with the purpose of integrating the previous information; b) it makes the reading task uninteresting and tedious due to slow rate of reading. This last point deserves more attention as far as reading instruction is concerned. It goes without saying that one important characteristic of skilled readers is their speed in word recognition and reading which is the result of automatic processing of the reading material.

#### 5.3.5.4. Researcher-directed Question (n)

As its name indicates, the strategy reveals the subjects' need to incorporate outside sources of information into their processing text comprehension. The great majority of examples of this strategy were word-related. To exemplify the researcher-directed question strategy the following example taken from NI4's protocol is provided:

#### Text 2

S6: Some individuals, in other words, have characteristics that have a survival value and we say that they are better adapted to their environment than the others.

#### Protocol

/I don't know the meaning of 'survival'/ do you mind if I ask you its meaning?/

#### Commentary

*The subject resorts to the simplest available source of information to tackle the meaning of an unknown item of vocabulary.*

The strategy obviously deters comprehension simply because it firstly prompts the subject to select the easiest way of getting information and thus allows less contribution to and interaction with text and increases one's dependency on outside-the-text resources for tackling comprehension problems. Secondly, it prevents one from developing more sophisticated strategies such as inferencing from the context. However, it was thought that the strategy was probably an artificial product of the experimental situation which would not otherwise occur in normal reading.

#### **5.3.5.5. Using Dictionary (n)**

A cognitive strategy that the novice readers employed to solve comprehension problems was using the dictionary. An interesting point to be mentioned here is that although the readers were expected to refer more frequently to the dictionary due to their problems with items of vocabulary, only two of them, that is, NI2 and NI3 employed the strategy 11 times. Unlike other novice readers, NI2 and NI3 both employed the reprocessing to retrieve word meaning strategy more frequently than other novice readers. This preoccupation with extracting word meaning was probably the main cause for using the dictionary frequently.

However, too much reliance on using the dictionary may cause one to get stuck with it and is harmful to developing other independent strategies such as inferring



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meaning from context and activating academic background knowledge. Commenting on her failure to identify the items of meaning of two vocabulary items in S13 of T1, NI3 says:

**/ I can no longer read the sentence/ I can't read the sentence as soon as my eyes fall on these two words/ cause I feel I don't know these two words and consequently I am unable to read it/**

This habit may in turn cause confusion when one does not have access to a dictionary as is shown in her verbalization of S14 of T1:

**/ 'possess'/ 'possess'/ 08/ I don't know what it is / I am confused/**

Not having access to a dictionary, NI4 appeared to be too dependent on the dictionary in solving her comprehension problems. She repeatedly confirmed it after her various vocabulary related strategies failed. This in turn caused her not to apply other comprehension strategies such as inferencing.

To sum up this section, the protocols of the students showed that the novice readers frequently resorted to decoding items of vocabulary to recognize unknown lexical items and make meaning representation. Another lower level strategy showing the readers' occupation at word recognition level is word for word translation in which the readers process the text by slowing down the process and

breaking the sentence at phrasal level. LI-equivalent search is also an indication of attempting to help understand a given word by trying to provide a synonym for it. Researcher-directed question signifies the readers' desire to use external sources of information to help detecting word meaning. Closely related to the researcher-directed question strategy is using dictionary where some novice readers chose the easiest way of dealing with the dilemma of word recognition.

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### 5.3.6. Phonemic/graphemic Decoding

#### 5.3.6.1. Word Identification Based on Phonological Similarity(c)

A reading comprehension strategy, word recognition based on phonological similarity was used 11 times by half of the novice reader informants. The following excerpt taken from NI8's protocol provides a better understanding of the strategy:

| Text 1   | Protocol   | Commentary   |
|--|--|--|
| S3: The plants can use this energy because they possess the green pigment chlorophyll. | /I stopped on the word 'possess'/ 01/ I don't know its meaning/ 01/ perhaps/ it pulls one towards that background that it is perhaps derived from 'pass'/' | <i>It is an inference at word level based on phonological similarity with another word to help one to tackle the meaning of an unknown word.</i> |

Research in language reading comprehension has shown that such a strategy is characteristic of the readers who face problems in deciphering meaning and try to

make a match between an unknown word and what is known on the basis of phonological similarity between the two. In light of the reading theory postulated earlier, the strategy relates to mis-identification of a word on the basis of its phonological similarity. The strategy can best be explained within the interactive theory postulated by Rayner and Pollatsek (1989). Concerning lexical access, the model predicts two routes: a direct route (see figure 3.5.) which involves a direct processing of lexical access from foveal word processing to lexicon section in LTM, and an indirect route (i.e. going through sound). Lexical access occurs through one of these routes. As the model predicts in the case of a totally unfamiliar word one would apply analogical rules from known words to the unfamiliar words. The above example shows that the subject does not know 'possess' and tries to compare it with an apparently known lexical item sharing some phonological features in order to get its meaning.

The success of this strategy, as one might assume, is bound to the reader's repertoire of vocabulary. Readers with limited vocabulary resources have a limited number of possible alternatives which means little success in retrieving word meaning.

Looking at the skilled readers' protocols, evidence of the use of the strategy was found. An important finding in this regard relates to the evidence rejecting



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McLaughlin's (1987b) findings that the skilled readers paid attention to meaning and not the phonetic decoding.

On three occasions throughout his think-aloud verbalization, SI7 unconsciously commits malapropism mistakes by interpreting 'evolution' in S75 as 'revolution', 'mission' as 'session' in S45 and 'rotting' as 'root' in S35. However, although the first two sets of words are graphically and phonetically tricky, there is no reason as to why he misinterpreted 'rotting' as 'root'.

Furthermore, evidence showing that the skilled readers as well as the novice readers used their auditory comprehension to assist reading comprehension comes from their use of reading aloud. For example, SI5 read the whole last paragraph in a reading aloud manner. In his retrospection he said the reason for this was trying to focus his attention more on the paragraph simply because it was the last paragraph and that he had found it important in terms of its concluding remarks and implication for future research.

#### 5.3.6.2. Integrated decoding (n)

As the name of the strategy indicates, it is basically a word-related move used in order to tackle word meaning by an initial compartmentalization of words into syllables followed by rising/falling intonation. The difference that it has with the

decoding strategy is reflected in the sing-song intonation of the decoded element at the end of the decoding process. While an element of seeking confirmation is present in the integrated decoding strategy, it is lacking in the decoding strategy.

An example of this strategy is as follows:

| Text 2   | Protocol   | Commentary   |
|--|--|--|
| <p>S1: When an organism stops reproducing, its own survival becomes unimportant.</p> | <p>/its own survival/ 'it becomes'/<br/> <u>um/</u><br/> <u>'unimportant'/</u><br/> <u>'unimportant'ʔ/</u><br/> <u>'unimportant'ʌ/</u></p> | <p><i>The strategy shows subject's attempt to tackle word meaning by firstly dividing the word into syllables and then using rising and falling intonation to help word retrieval.</i></p> |

The decoding process takes place with a self-directed rising intonation and a falling one. As the verbal data above show, the reader informants (i.e. NI2 and NI7<sup>10</sup>) first attempted to identify the word by breaking it into syllables. The strategy reflects a bottom-up decoding with a slowing down of lexical access from long term memory. It is only after making a conceptual frame for the word (that is, after getting it as a whole word 'unimportant') that the subjects try to monitor it by a self-directed question exemplified in its rising intonation. Sound encoding appears to play some part in accessing the meaning of words. According to Rayner and Pollatsek's interactive model, phonological codes may aid

<sup>10</sup> See appendix B for a full transcription of NI7's think-aloud protocols

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comprehension through information about prosodic structure. By using prosodic information in sentence processing, the reader must find some way to compensate for the lack of prosody in reading and reorganize the sentence into a prosodic structure. This apparently shows that the reader strives to get access to long term memory to find a match between the word and its corresponding schema word (i.e. 'unimportant') in LTM.

Nevertheless, as the novice readers' protocols show the strategy fails due to lack of lexical meaning representation to be matched with the unknown word. The falling intonation followed by no comment as to the success of the strategy is indicative of the reader's failure to retrieve the unknown words from the LTM..

This section examined two different strategies which showed word decoding at phonemic/graphemic level, that is, word identification based on phonological similarity and integrated decoding. The former is an example of the readers' attempt at getting the meaning of an unknown lexical item while in the latter the readers compartmentalize words into syllables followed by rising/falling intonation. The sound encoding of the words provides supporting evidence for the Rayner and Pollatsek's interactive model of reading. In addition, subjects' use of reading aloud which makes use of auditory comprehension in understanding text was examined.



### 5.3.7. Syntactic Processing

#### 5.3.7.1. Grammatical Analysis (n)

The novice reader informants showed that they were also engaged in structure analysis in order to get access to the meaning of the text. The following excerpt taken from NI2's protocol reveals an instance of this attempt, though unsuccessful here, on the part of the novice readers:

| Text 1   | Protocol   | Commentary  |
|--|--|---|
| S1: Plants characteristically synthesize complex organic substances from simple inorganic raw materials. | /'plants characteristically' / character now must be an adjective/ and adjective for plants/ | <i>The strategy is an attempt to facilitate understanding of a partly unfamiliar structure.</i> |

As McLaughlin (1987 cited in O'Malley and Chamote 1990) demonstrated, there are differences in syntactic processing between proficient and less proficient speakers of a second language. More proficient language readers focus on meaning and process the structural aspects of text automatically. This automatic processing of structures is not evident in the above protocol produced by NI5. Attention is rather focused on analyzing an adverbial phrase. This would demand the reader informants to devote attention and processing energy to encoding both meaning and structure. Strategies like this could be explained within the interactive model of Rayner and Pollatsek.

According to the model, the main function of the parser is to parse strings of words into their appropriate syntactic constituents. The strategies are primarily based on one particular theory of parsing: the *garden path* model of sentence processing (Frazier and Rayner, 1982 cited in Rayner and Pollatsek, op.cit.). According to the model, words in a sentence are assigned an initial syntactic analysis based on structural information. An important strategy discussed earlier is 'minimal attachment' strategy by which the reader uses 'the fewest nodes consistent with the well-formed rules of the language under the analysis' (P:246), attaching new information into the phrase marker being constructed.

Obviously, in the case of the above protocols an explanation that the minimal attachment strategy was the main motivation for parsing the sentence may seem implausible since the rule initially applies to the situation under which first language is analyzed. However, viewing the protocol from the perspective of a second language learner having a different syntactic rule system, we would then be able to account for that. Put simply, syntactic word order in Farsi, the mother tongue language of the reader informants in this study, for a string of adjective/noun is reverse. In other words, while the order in English for a phrase such as *big boy* is adjective/noun, a Farsi speaker uses it as *boy big* (i.e. noun/adjective). We may assume that NI2 transferred his first language

knowledge into interpreting a phrase structure in English, though he mis-identifies an adjective with an adverb.

NI6 and NI8 showed to have problems with the somewhat lengthy discourse markers such as 'on the other hand' used rhetorically by the writer to maintain nominalization in S5 of T1. The structure which separates the subject from the predicate or delays the occurrence of the predicate by the insertion of lengthy discourse markers is referred to in the EST literature as 'syntactic discontinuity' (Bhatia, 1987) and is one of the problematic areas for novice foreign language readers. The following is an example of NI6's think-aloud data in this regard:

**Text 1****Protocol**

**S5:** Animals, on the other hand, must obtain complex organic substances by eating plants or other animals.

**RS/05/** the first part of the sentence was quite clear/ 02/ but not the second part/ I got the sentence up to 'must'/ to get the second part I must reread the sentence from the beginning/

Grammatical analysis is an example of the reader's need to parse a piece of language item for the purpose of text understanding.



## Section II

### **5.4. Individual Profiles Of The Novice And The Skilled Readers**

This section expounds the reading processes of each individual novice and skilled reader informant of the study by observing the strategies used by the readers and providing examples taken from the subjects' protocols. The purpose of doing this was thus to check first what mixture of strategies was used by the subjects in their attempts to solve a comprehension problem in the hope to find out certain common strategies employed by the subjects and second to determine the sequence of strategies used by the readers, to see persistence of a model or models of reading comprehension in protocols of the readers.

The answer to the above issue will shed light on; first, whether to attempt to design a course of teaching strategies to the novice readers as has been advocated by some researchers; secondly, to provide an answer for the thorny question of individual differences in reading; and finally, to examine the extent to which the choice of strategies reflects readers' attempt to resort to an amalgamation of the strategies, or to choose an interactive approach to reading comprehension.

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To sequence the strategies, I used an information processing model (see also chapter three, theoretical basis of introspection). Language processing in the information processing approach is viewed as *a sequence of psychological stages* that occur between 'the initial presentation of the language stimulus and the meaning in the mind of the language processor' (Massaro, 1975; P: xi). The goal is to define each of the processes and structures involved and to understand how each of them operates.

The information processing model employed in this study examines each processing stage and its subsequent stages used by the readers in their attempt to understand the texts. A stage involves the reader's decision to tackle a problem in comprehension exemplified in employing a reading strategy. A stage is, therefore, characterized by presentation of the problem (i.e. *problematicity*, which refers to the time when a problem in comprehension is detected), the reader's recognition of the essential features of the situation by selecting an appropriate strategy (i.e. *consciousness*, which refers to the reader's awareness about the use of a strategy utilized for a particular purpose), and employing it to solve the problem (i.e. *intentionality*, which refers to the reader's particular strategy selection from among a range of choices to achieve certain effects). As was discussed in chapter one, these three characteristics were discussed to be essential ingredients of a reading comprehension strategy. In the analysis of each stage due attention is rather paid

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to the result of such a processing, that is, reading strategies. We understand language processing to the extent that we understand each of these processing stages.

The procedure for externalising this sequence begins with recognizing, and sequencing strategies used by the readers for every single sentence in their verbal reports. To count the strategies, some caveats are in order. 1) To determine what strategies were used in the first stage, instances of using a given strategy was first identified and then tallied<sup>11</sup>. 2) Sequencing the strategies for a given problem may not necessarily start from the beginning of a sentence. It may rather start from wherever the subject identifies a problem and therefore employs different strategies for solving the comprehension problems. 3) Certain strategies such as word for word translation were counted only once for the sentences on which the strategy was imposed. If, however, word for word translation was interrupted by another strategy but was later resumed, this second application was considered at the third stage. 4) Specifying the dominant reading model exemplified in different forms of strategies at each stage depends first on the highest frequency of occurrence of that strategy and second on the type of the strategies used at that stage. For example, if the decoding strategy is used 10 times

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<sup>11</sup> Strategies which due to insignificant frequency of occurrence (that is, appearing only once across subjects) were not considered in the classification scheme are not brought in here too to account for the reading process (see page 201).



and appears to be the dominant strategy in comparison to other strategies in that stage such as main idea construction with a frequency of occurrence of 2 the reading model at that stage would be called bottom-up interactive. 5) Some subjects read aloud the whole text while some employed the reading aloud strategy on some occasions. The former use was not counted since it reflected the reader's mode of reading or habit, so to speak. The latter use, however, was given consideration in the frequency count. 6) Normal continuation of the text whose previous parts were processed due to readers' comprehension problems was not considered a strategic move. 7) The cognitive strategies used in each phase of strategy use are not in any way ordered hierarchically.

Based on the list of strategies mentioned earlier in this chapter, the strategies for different stages of text processing were therefore tallied and counted for the frequency of occurrence. The following is a list of abbreviations used for each strategy together with a sequencing sample of strategies of NI2's protocol.

### List of abbreviations

| <b>Abbreviation</b> | <b>Items</b>                               |
|---------------------|--|
| UBK                 | Using background knowledge                 |
| PRTD                | Predictive recognition of text development |
| SDQ                 | Self-directed questions                    |

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|      |   |
|------|---|
| STS  | Skipping trivial sections                                 |
| SDS  | Skipping difficult sections                               |
| CS   | Controlled skipping                                       |
| P    | Paraphrasing  |
| PWD  | Paraphrase with deletion                                  |
| RPG  | Reprocessing to get the gist                              |
| RPLS | Reprocessing long structures                              |
| RPA  | Reprocessing to assemble                                  |
| RPWM | Reprocessing to retrieve word meaning                     |
| H    | Highlighting for reprocessing                             |
| IF   | Inferencing   |
| W    | Watchers  |
| ICC  | Identification of comparison/contrast                     |
| RWM  | Repeating to get word meaning                             |
| RA   | Reading aloud   |
| MIC  | Main idea construction                                    |
| R    | Relating  |
| LES  | L1-equivalent search                                      |
| DEC  | Decoding  |
| WFWT | Word for word translation                                 |
| RDQ  | Researcher-directed questions                             |
| DIC  | Using dictionary  |
| WIPS | Word identification based on -<br>phonological similarity |
| IN   | Integrated decoding                                       |
| GA   | Grammatical analysis                                      |
| *    | Confirming understanding                                  |
| **   | Statement of failure                                      |
| /Mt/ | Muttering   |
| →    | then  |
| S1   | Sentence number   |
| F    | Frequency   |

**Text 1**

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S1: rpwm→rwm→\*→rpg \*;  
 S2: S;  
 S3: rwm→rpwm→cs→\*;  
 S4: \*;  
 S5: rwm→cs→rwm→\*\*→rpwm→sdq \*;  
 S6: rwm→rpwm→\*\*→sdq→\*;  
 S7: rwm→ga→cs→rwm →\*\* →dic;  
 S8: rwm→rwm→rpwm→dic;  
 S9: rwm→rwm→\*\*→dic;  
 S10: \*;  
 S11: \*;  
 S12: \*;  
 S13: rwm→rpwm→rwm→/Mt/→cs→ubk→rpwm→\*;  
 S14: sdq→if→sts;  
 S15: sdq→rwm→rpwm→dic→rwm→rwm→dic;  
 S16: \*  
 S17: rpg

## Text 2

S1: rpg→rpg→rwm→rpg→rwm→rwm→rwm→dic;  
 S2: in→rwm→rwm→\*\*→rwm→rwm→dic→rwm→rwm→wfwf;  
 S3: rwm→rpwm→/Mt/→rwm→dic;  
 S4: in→rpwm→in→/Mt/→rwm→dic→rwm→wfwf→sdq→/Mt/→cs;  
 S5: wfwf→If→dic→\*;  
 S6: /Mt/→sdq→in→sdq→rwm;  
 S7: in→rwm→rwm→rwm→rwm→in→w→rpwm→rwm→/Mt/;  
 S8: rwm→rwm→rwm→rwm→\*\*;  
 S9: wfwf→in→wfwf→ga→rwm→if;  
 S10: in→rwm→in→rwm→rpwm→/Mt/→cs;  
 S11: rwm→rwm→rwm→rwm→rwm→rwm→rwm→\*;  
 S12: rwm→if→\*;  
 S13: \*;  
 S14: sdq→if→rwm→\*;  
 S15: rwm→rwm→\*;  
 S16: wfwf→sdq→if→\*;  
 S17: rwm→rwm→wfwf→\*.

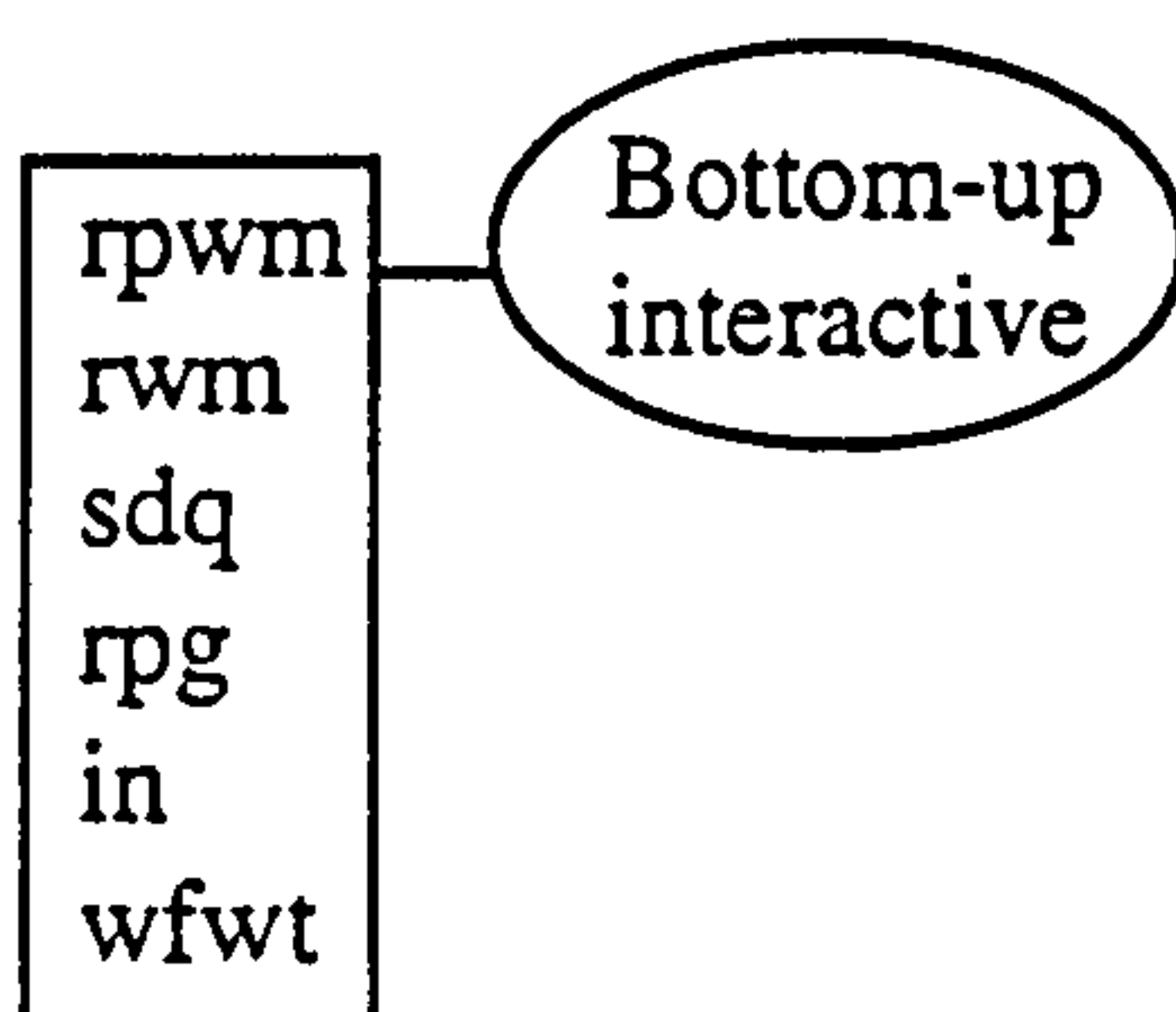
**Sample sequencing of strategies of each single sentence in NI2's protocols**



The synthagmatic representation of the strategies in the first sentence used by NI2 shows that he resorted to three different strategies to tackle a comprehension problem. His protocol for the first sentence is as follows:

**/S1/ plants characteristically synthesize/ I read from the beginning to get 'synthesis'/ 'plants characteristically synthesize complex organic substances from simple raw materials'/ 'raw materials'/ aha I got it/ now I read the whole sentence to see if I got the sentence/ 'plants characteristically synthesize complex organic substances from simple inorganic raw materials'/ yes I got it/ :**

To sequence strategies used as his first attempts to solve comprehension problems, every strategy was put in a box and its frequencies were counted. For example, NI2's initial strategies consisted of reprocessing to get word meaning (F:1), repeating to get word meaning (F:11), self-directed questions (F:2), reprocessing to get the gist (F:2), integrated decoding (F:4), and word for word translation (F:2). An example of such arrangement is as follows:



In order to account for the reading process of this stage both the frequency of occurrence and type of the strategies were observed. The strategies employed in the first stage are mainly bottom-up interactive strategies or strategies which

draw upon different sources of information from top-down to bottom-up but with more orientation towards the latter. While some strategies such as repeating to retrieve word meaning deal with word recognition, other strategies such as integrated decoding deal with simultaneous provocation of decoding and relying on phonological codes in tackling an item of vocabulary.

#### **5.4.1. Novice readers**

This section portrays each novice reader's text processing as explained above. It is however, important to know that many of the arrows and boxes present in the following schematic representation of NI2's reading protocols are omitted for the subsequent readers' reading protocols simply for the sake of avoiding repetition to make them more user-friendly.

The overall reading processes of NI2 as represented in the schematic sequences of strategies in the below flowchart shows that he resorted to nine main stages of strategy application in order to overcome problems resulting from comprehension failures. As can be seen, the subject initially started reading. Upon realizing a problem in comprehension, he planned to choose a series of strategies to tackle the problem. Considering reading as a problem solving activity one would call this stage of strategy application the initial stage of text processing. The performance of NI2 on the experimental texts indicates the general pattern of reading as a problem solving activity and is typical of all novice readers in this study. That is,

the chain of reading comprehension process begins with identification of comprehension problems, planning to choose certain cognitive strategies which was not externalized in their verbal report due to its automatic procedural nature, employing the cognitive strategies, and monitoring comprehension failure or success.

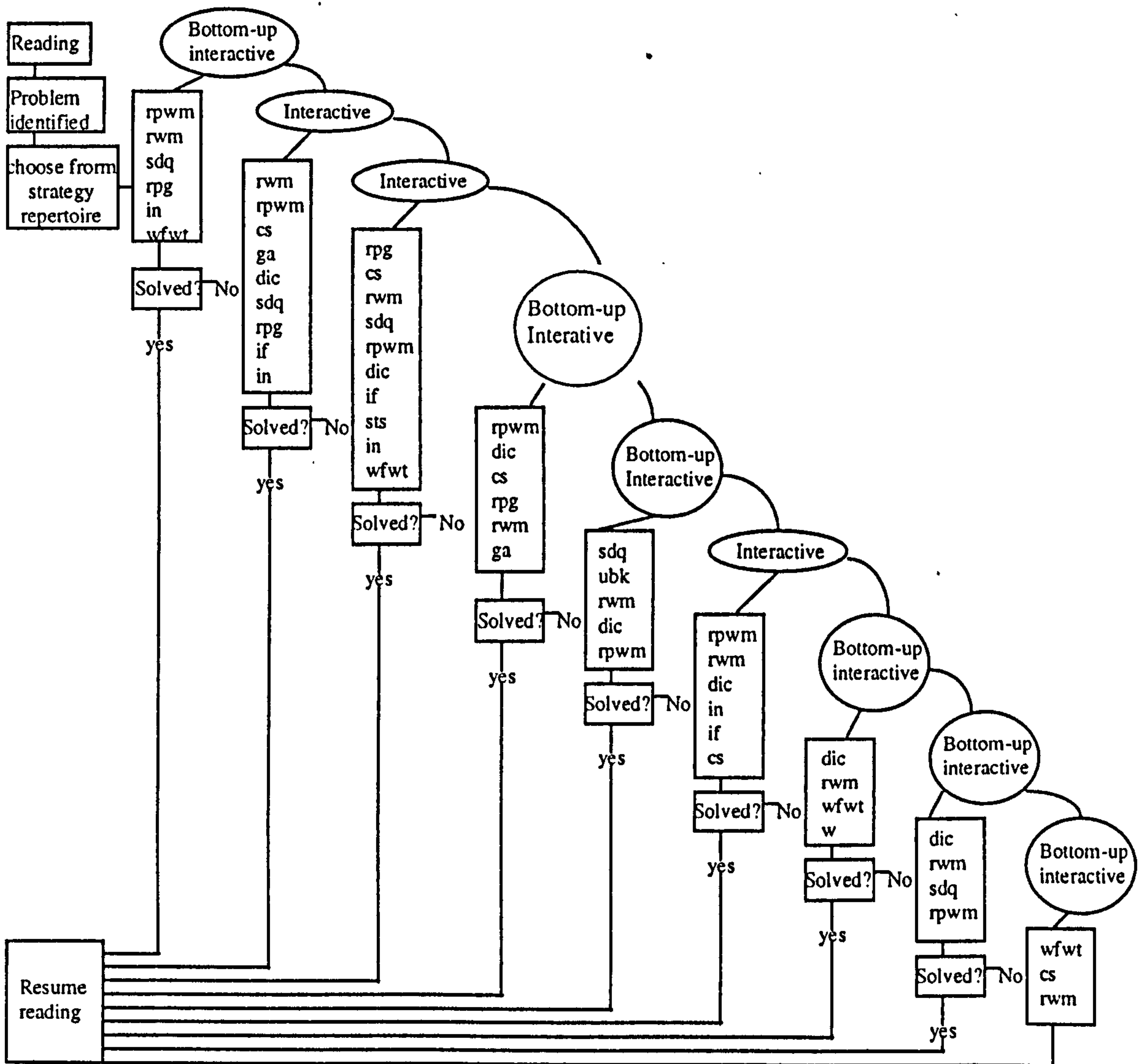


Figure 5.5. The overall sequence of comprehension strategies used by N12



The subject used the initial strategies depending on the problems he felt he had. For instance, if the problem was related to understanding the overall meaning of a given sentence, then reprocessing to get the gist was employed and if the problem was a word related one then, depending on whether the word was familiar at the first sight or not, he employed word for word translation or integrated decoding. Some similar strategies were employed if the problem was still persistent in his second attempt to solve the problem (i.e. second stage). If the strategy is perceived to be successful then the reader resumes reading, if not, the reader decides to try another cognitive strategy to tackle the problem. If, however, he could not overcome the comprehension problems, he employed a third category of strategies.

The second stage is characterized as interactive. The reason is that the subject uses a somewhat balanced bottom-up and top-down strategies. In like manner, the third stage is interactive. The overall picture of the strategies used by NI2 shows that he used a mixture of top-down and bottom-up strategies to tackle comprehension problems, though his reading process is somewhat oriented towards bottom-up interactive.

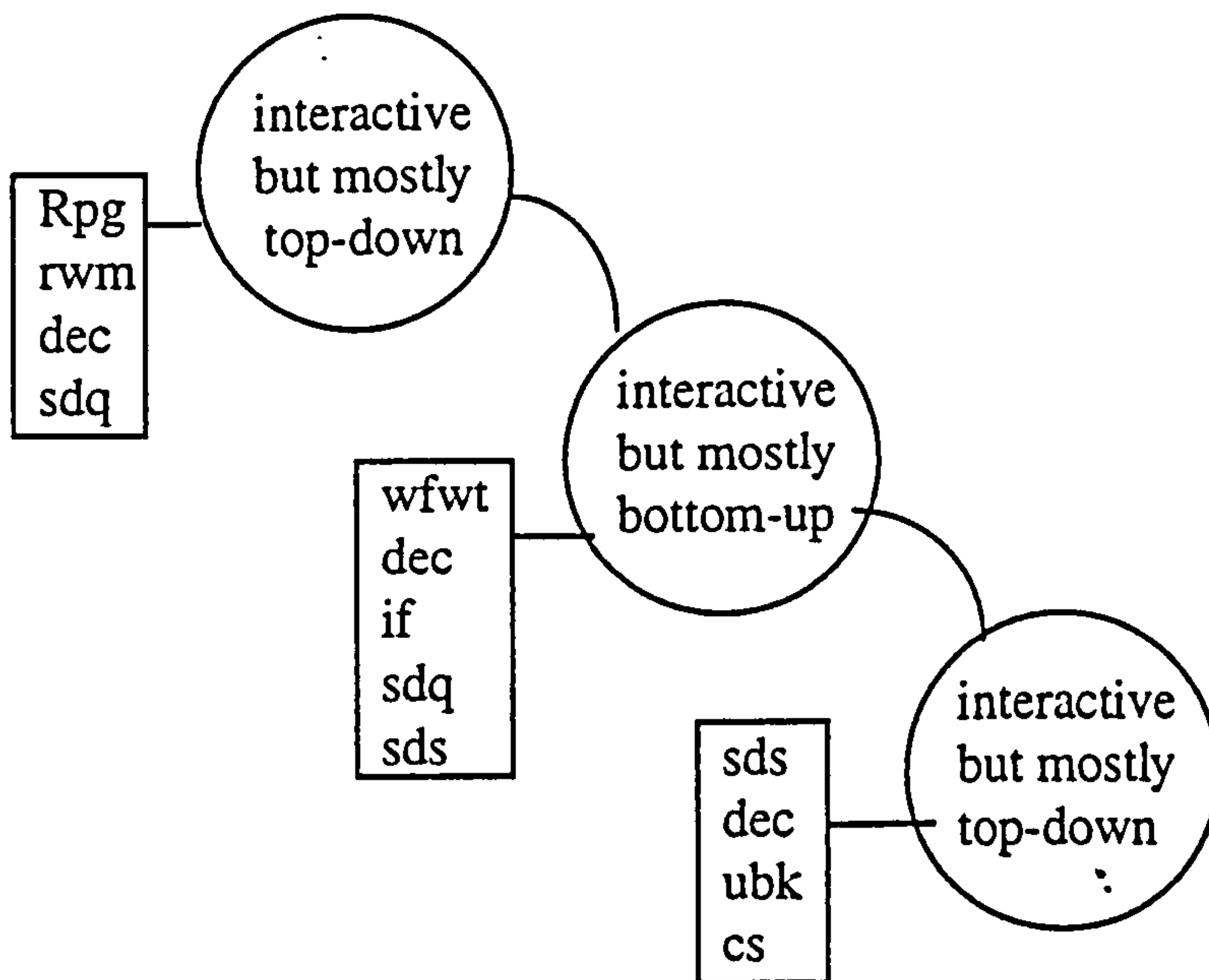
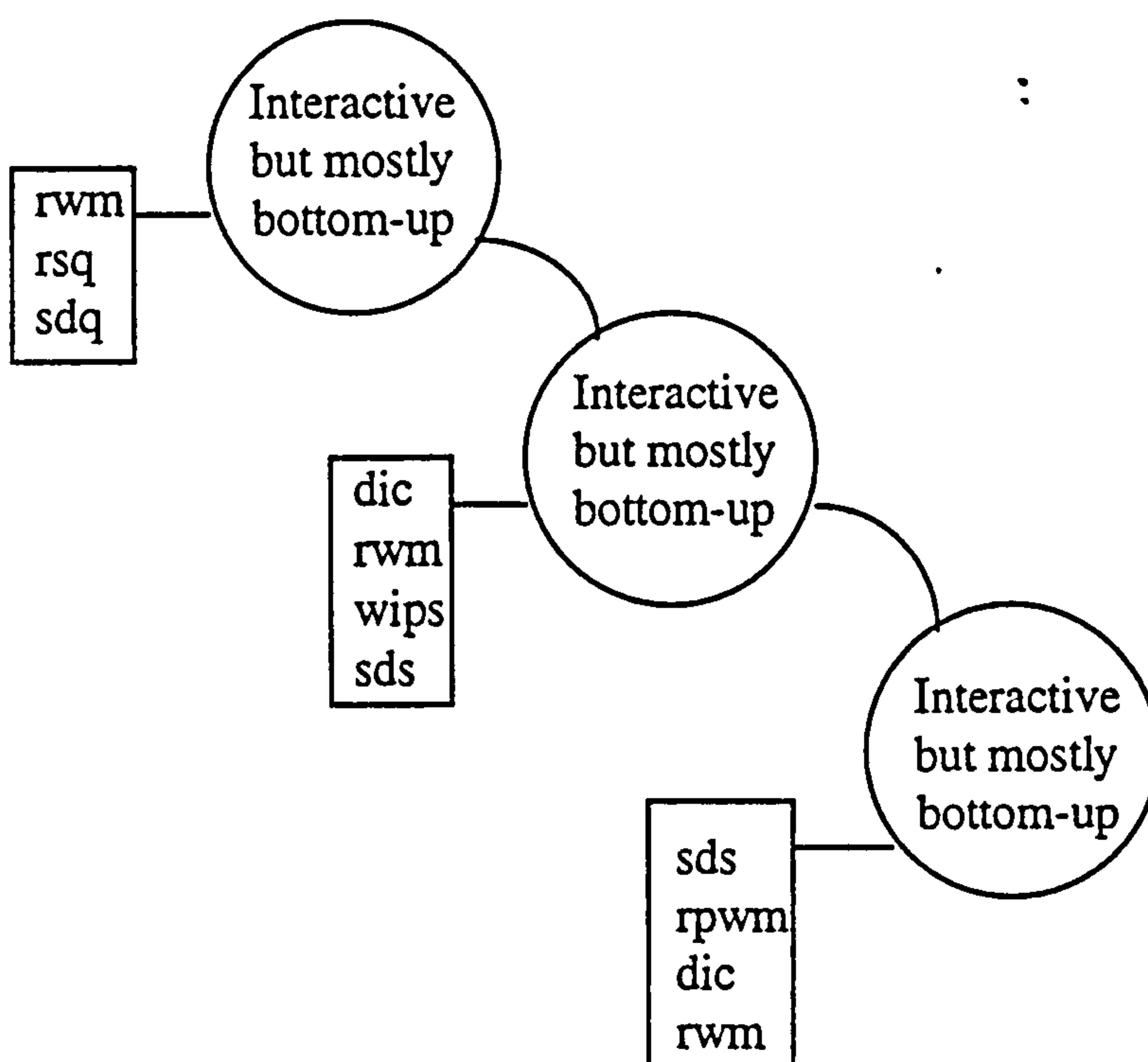


Figure 5.6. The overall sequence of comprehension strategies used by NI1

Despite NI2, NI1 employs three stages of using cognitive strategies in her approach to text comprehension. Hers begins with an interactive processing, continues with bottom-up and ends with almost top-down strategies. Decoding seems to be the only strategy present in the three stages of the comprehension processing.

Similar to NI1, NI3's protocols reflect three stages of using reading strategies. The strategies employed in the first stage are somewhat different from those used by NI1 and NI2. With the exception of *sdq* shared by NI1 and NI2 repeating to get word meaning is a shared factor among the three novice readers. The strategies used at this stage are rather bottom-up interactive. The second stage is characterized by another combination of mostly bottom-up

strategies such as, repeating to get word meaning, and word identification based on phonological similarity. Both NI1 and NI3 used sds at this stage. A somewhat similar set of strategies used in the preceding stage was employed by NI3 at the third stage, making it more of the same process used in the second stage.

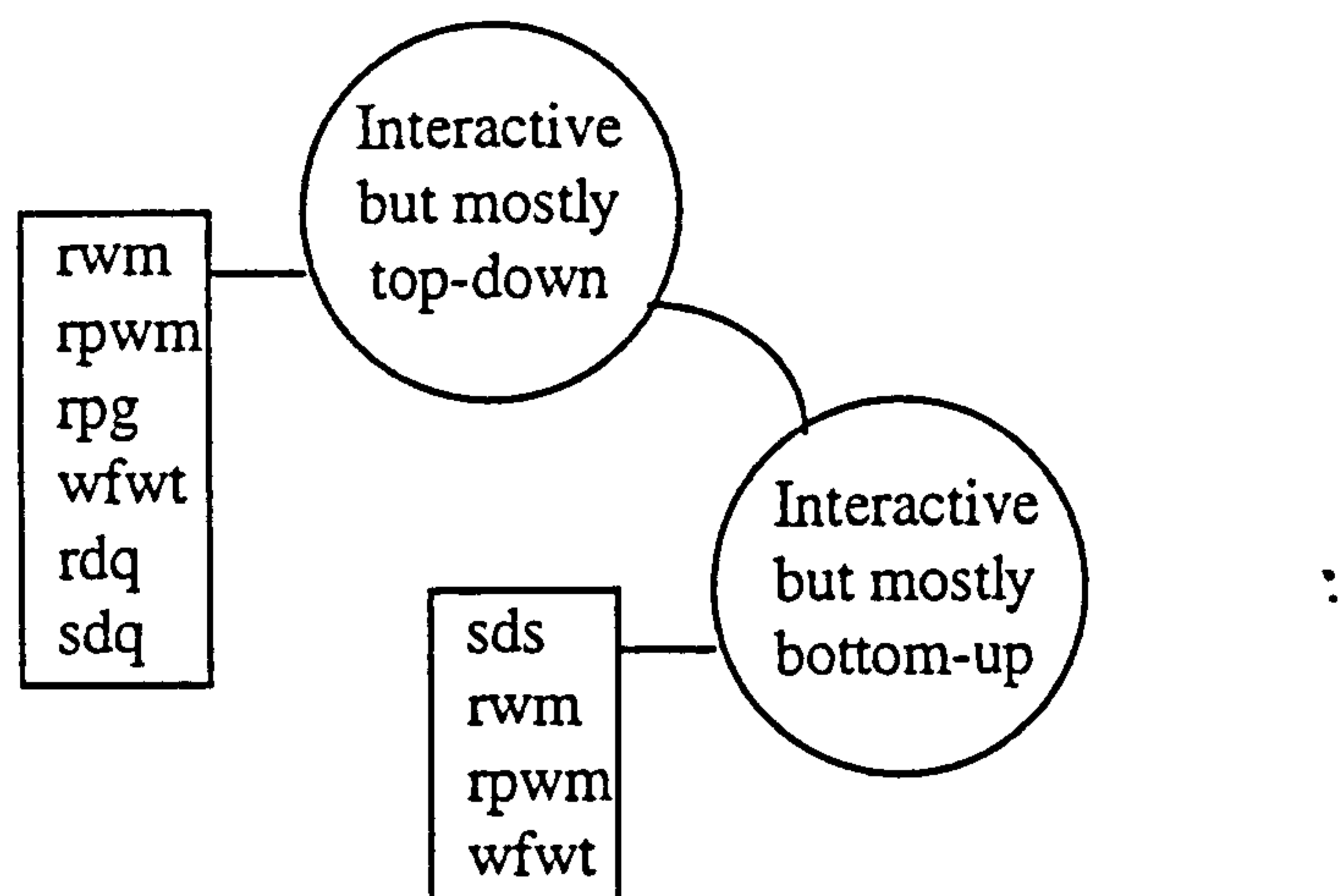


**Figure 5.7.** The overall sequence of comprehension strategies used by NI3

Compared to the previous readers, NI4 sticks to only two stages of employing reading comprehension strategies, but with a greater variety of strategies particularly at the initial stage. Due to overwhelming occurrence of top-down strategies at this stage (that is, reprocessing to get word meaning with a frequency



of 8) this stage is labeled top-down interactive. The second stage is characterized by the use of both top-down and bottom-up strategies with an overwhelming occurrence of the later, thus was labeled bottom-up interactive.



**Figure 5.8. The overall sequence of comprehension strategies used by NI4**

Like NI2, NI5 employs a greater number of comprehension problem solving activities represented in the greatest number of reading strategies than NI1, NI3 and NI4. In addition, he tackled comprehension problems by a greater number of reading strategies at the first stage than the other readers reported so far. An important feature of his approach to reading comprehension is the use of a greater variety of reading moves at earlier stages of solving comprehension problems. However, the schematic representation above shows a decrease in using reading strategies as he moves further down to the end of comprehension strategies. Three main strategies, that is, reprocessing to get the gist, grammatical analysis and inferencing, appear to have an overwhelming occurrence in almost all stages of his

comprehension strategies. A moderately balanced use of the reading strategies has made his efforts to appear interactive.

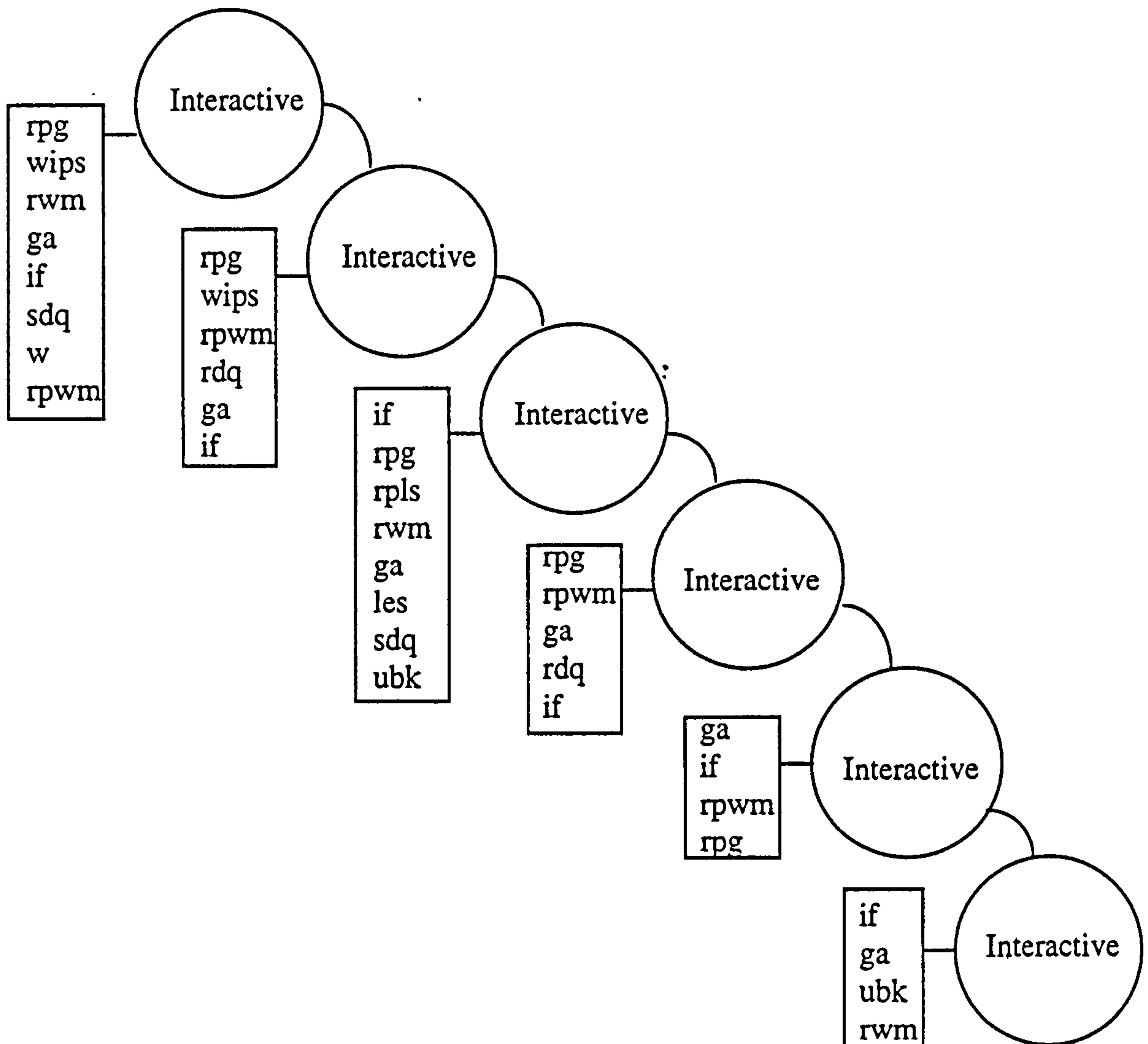
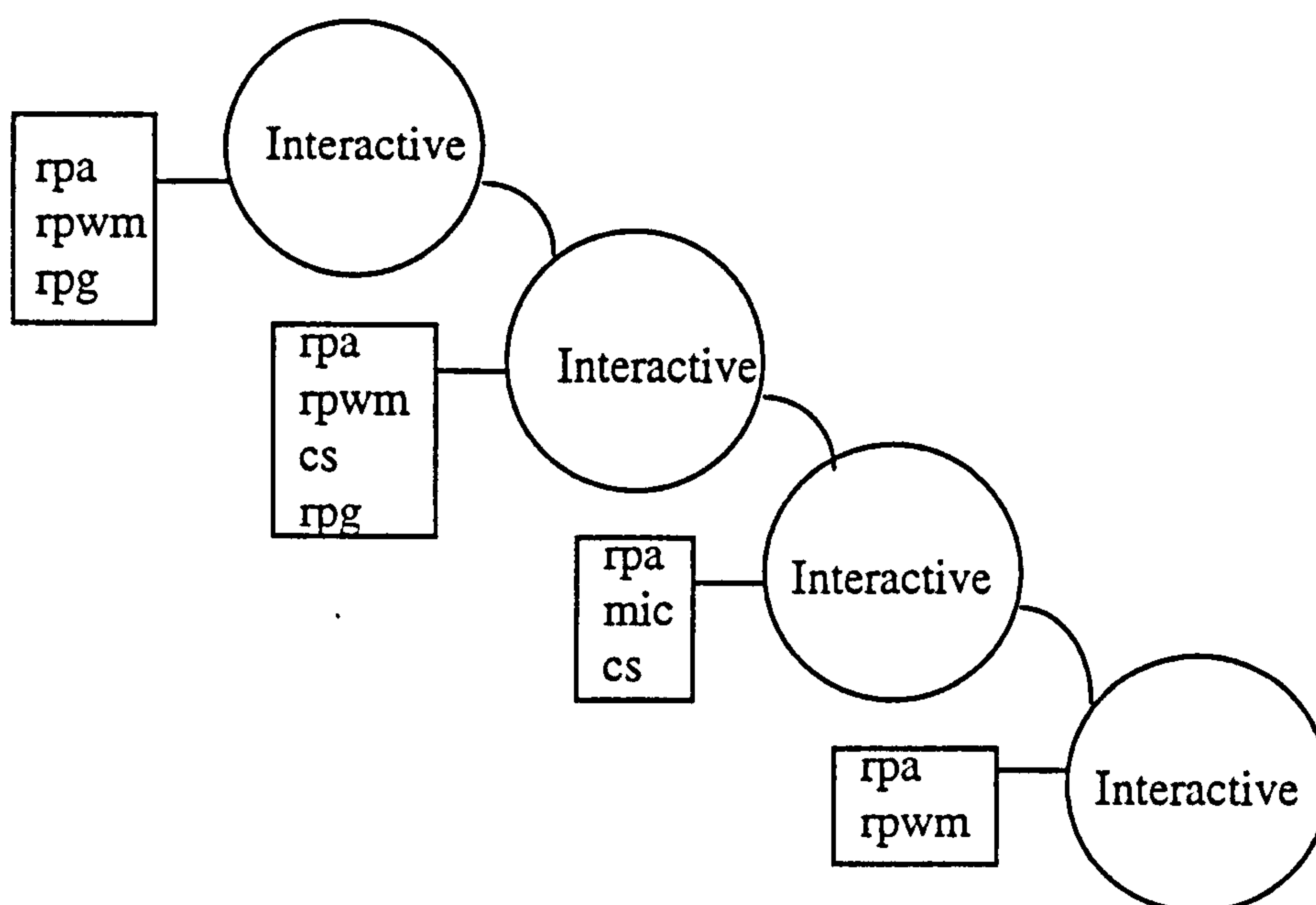


Figure 5.9. The overall sequence of comprehension strategies used by NI5

Fewer number of reading strategies characterizes NI6's approach to solving comprehension problems. Throughout four stages of comprehension strategy use, two main strategies appear to play a governing role, that is, reprocessing to assemble and reprocessing to get word meaning. Assuming that in strategies such

as reprocessing to assemble and reprocessing to get word meaning the subject resorts to all available source of information in the text to solve comprehension problems, his tendency to rely on contextual information or higher level processing could possibly be explained under Stanovich's (1980) theory of interactive compensatory approach. Over-reliance on the use of top-down strategies particularly in the case of reprocessing to get word meaning shows the subject's attempt to facilitate the simple recognition of words. Frequent use of top-down strategies at word level suggests a simple failure to decode properly.



**Figure 5.10. The overall sequence of comprehension strategies used by NI6**

Like NI5, NI7 appears to employ quite a few number of top-down and bottom-up strategies represented in her serious attempt to overcome comprehension problems. The highest frequency of reading strategies in first, second, fourth and fifth stages belongs to word for word translation, decoding, repeating to get word



meaning and 11-equivalent search which makes the contribution of the strategies more of bottom-up interactive nature.

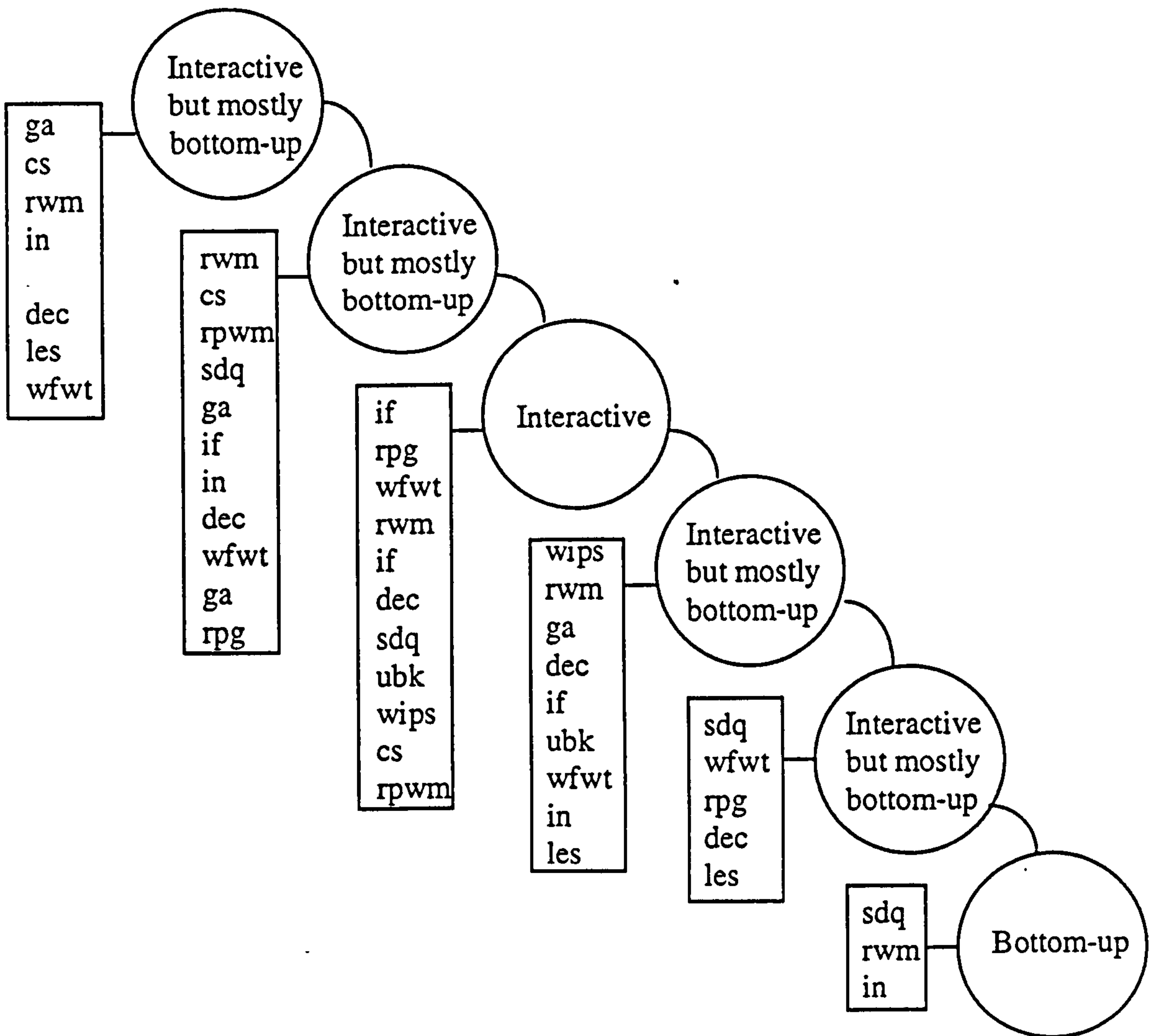


Figure 5.11. The overall sequence of comprehension strategies used by NI7

In contrast to NI7, NI8's approach shows a rather top-down bias in that he sticks more frequently to top-down strategies such as inferencing and reprocessing than purely bottom-up strategies. This is particularly evident in the first two stages of

employing comprehension strategies. However, as his attempts to tackle comprehension problems come to an end, a more balanced view is taken wherein final stages are characterized as interactive.

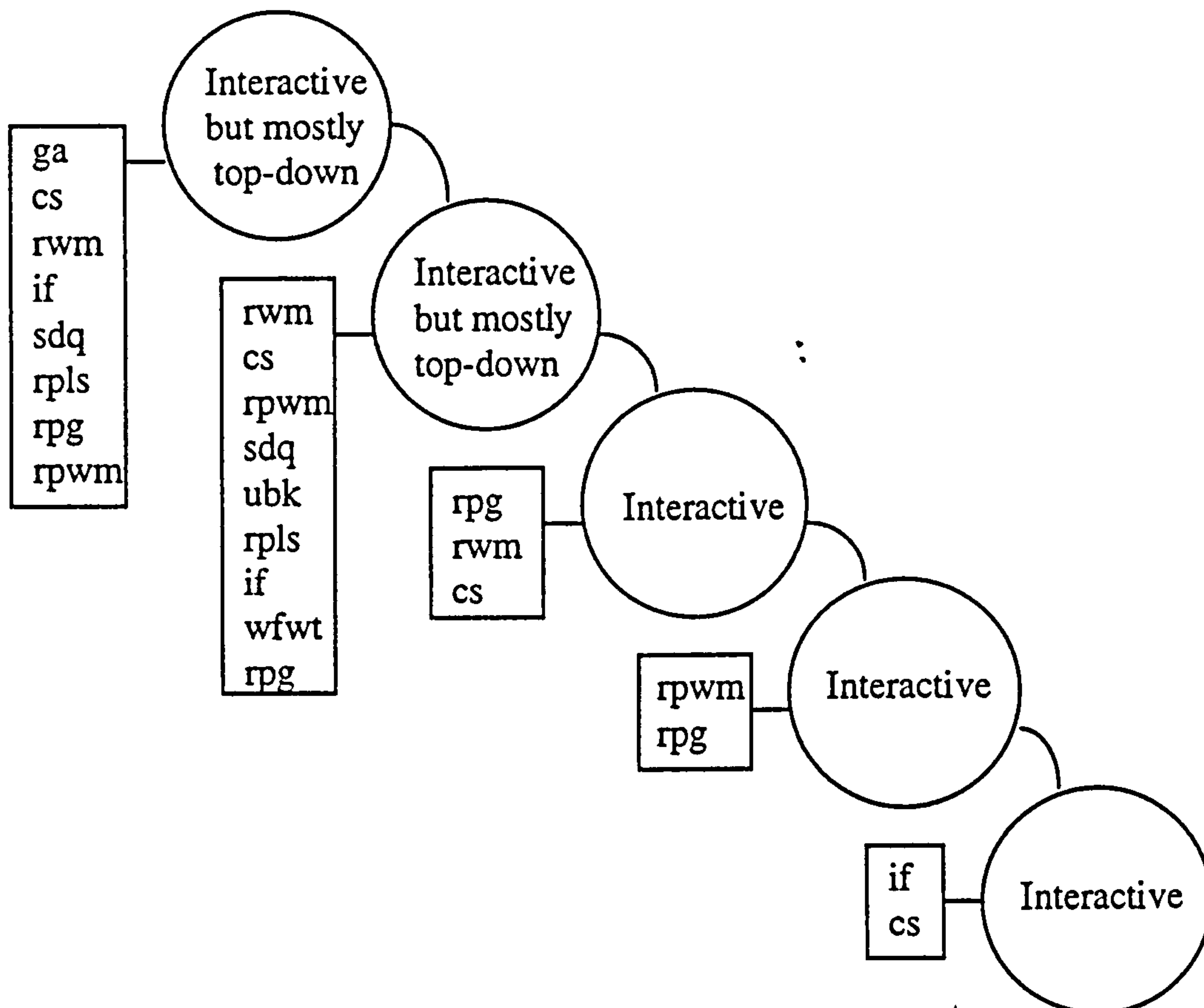


Figure 5.12. The overall sequence of comprehension strategies used by NI8

There is evidence of workbench memory overload in NI8's think-aloud data too. For instance, despite the rather easy and short structure of S6 of T1, it was reprocessed three times by the subject with an increasing time interval between each reprocessing, indicating the subject's greater involvement in and focus on the

sentence. In his last attempt, he understood the sentence and said that the reason for his previous failure was that he was still engaged in the previous sentence. As the data reveal, due to the limited capacity of STM it needs to be emptied in order for the reader to be able to process new data. As the time intervals between his reprocessing show this is a gradual step by step process.

### Text 1

S6: The reason for this is that they lack chlorophyll.

### Protocol

/RRS/ 02/ I reread the sentence/ 04/ It is still not known to me/ I reread it again/ 06/ now I got it / in fact the reason I didn't get it was that my mind was engaged in the previous sentence/

#### 5.4.2. Skilled Readers

An important feature of skilled readers' reading comprehension is their automatic reprocessing of parts of the experimental text..

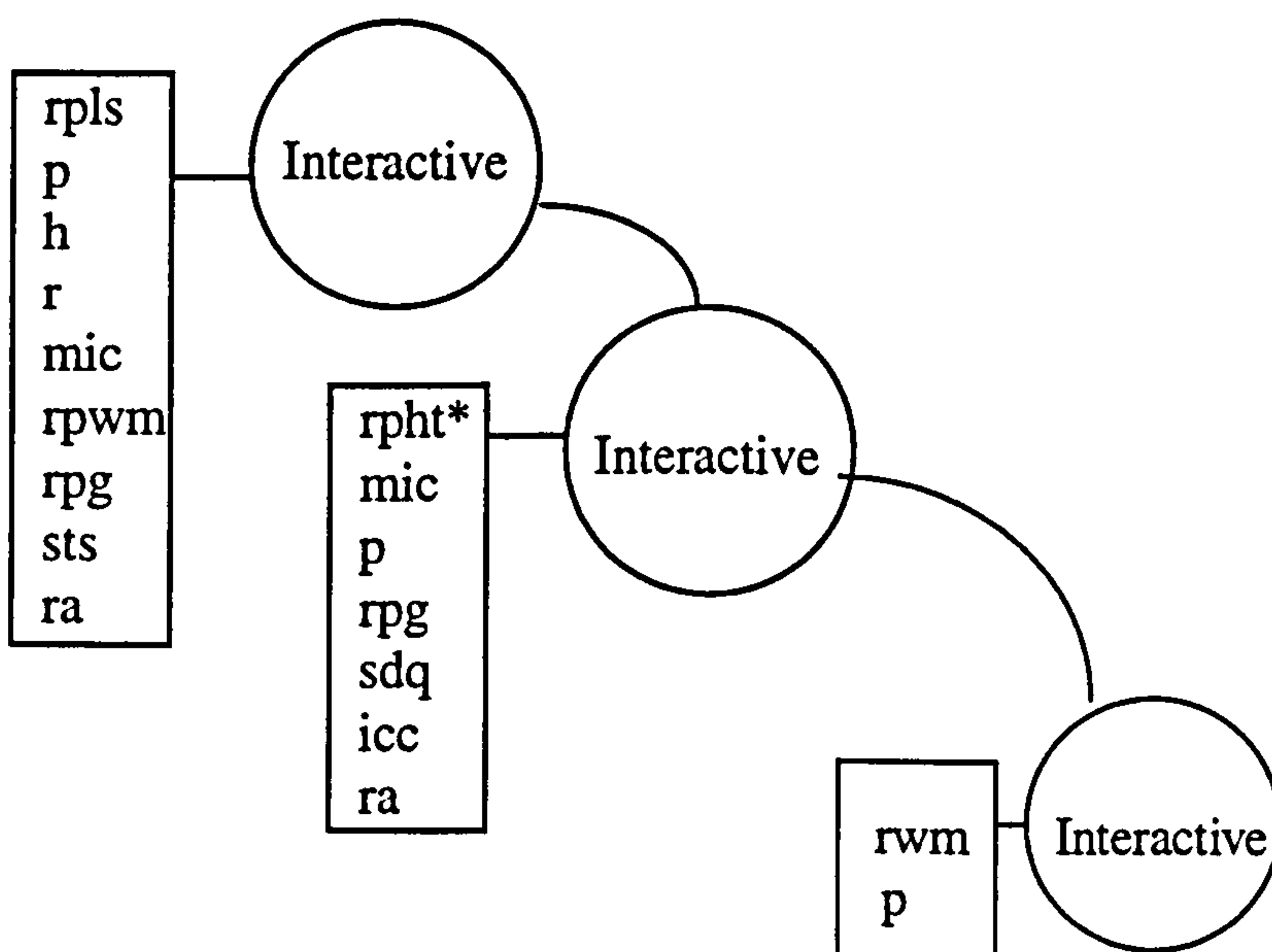


Figure 5.13. The overall sequence of comprehension strategies used by S11



Most of the skilled readers due to rapid automatic decoding did not report thought processes in their verbalization task. As for the reading strategies, SI1 went through three stages of reading comprehension strategies, all characterized as interactive with an overwhelming dominance of paraphrasing and highlighting in the first stage and a more balanced approach to take reading strategies with a somewhat equal frequency of occurrence at the second stage.

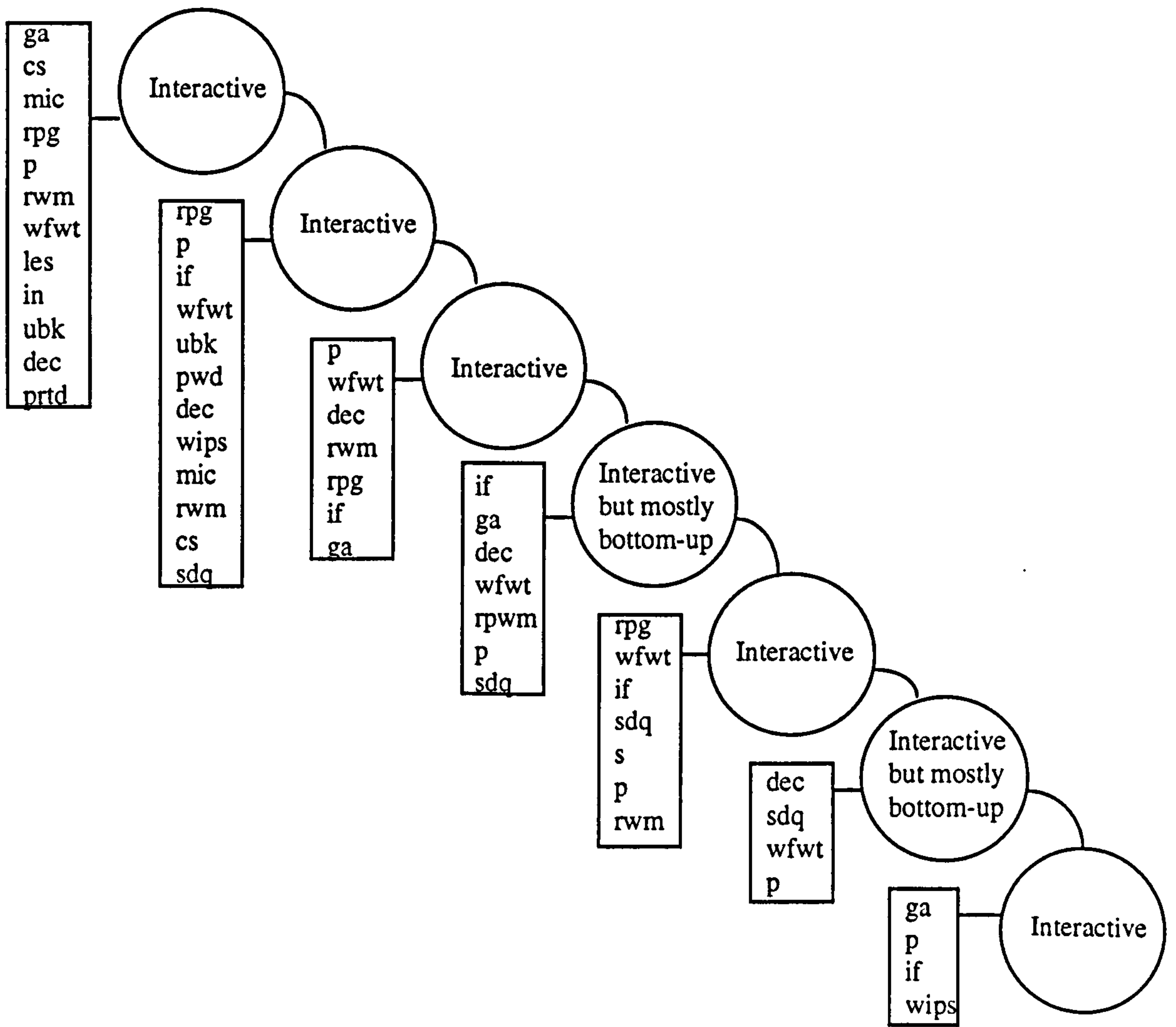


Figure 5.14. The overall sequence of comprehension strategies used by SI2

SI2 in contrast to SI1 used a rather lengthier sequence of strategies to maintain text understanding with a greater variety of comprehension strategies. The first and second stage are widely dominated by paraphrasing strategies.

Using fewer number of reading strategies compared to SI2, SI3 resorts to a balanced mixture of comprehension strategies particularly in the first two stages.

An important ingredient of all three stages of the strategy use is the presence of reprocessing to get the gist. Many of the sentences were not reported probably due to automatic processing of the text.

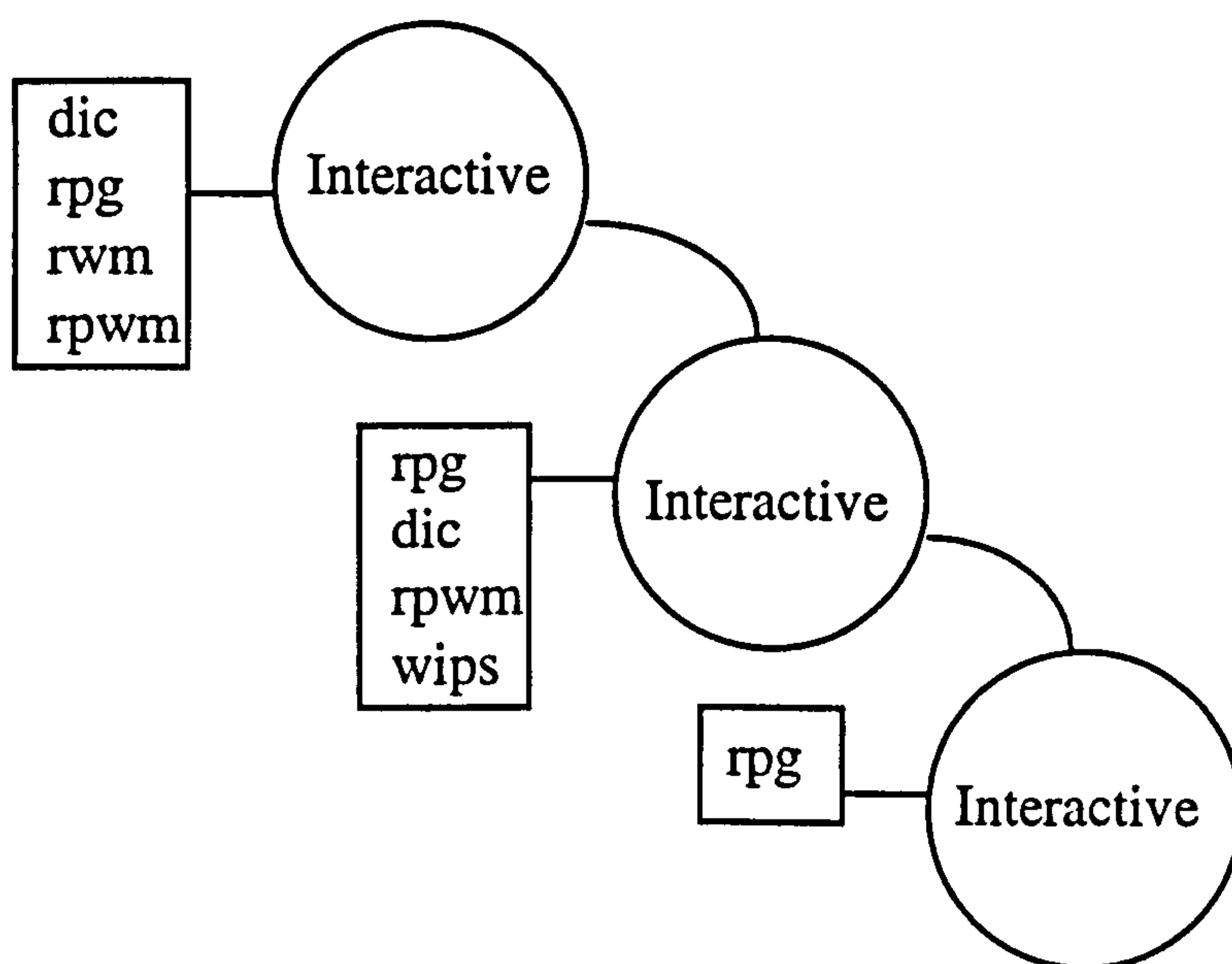
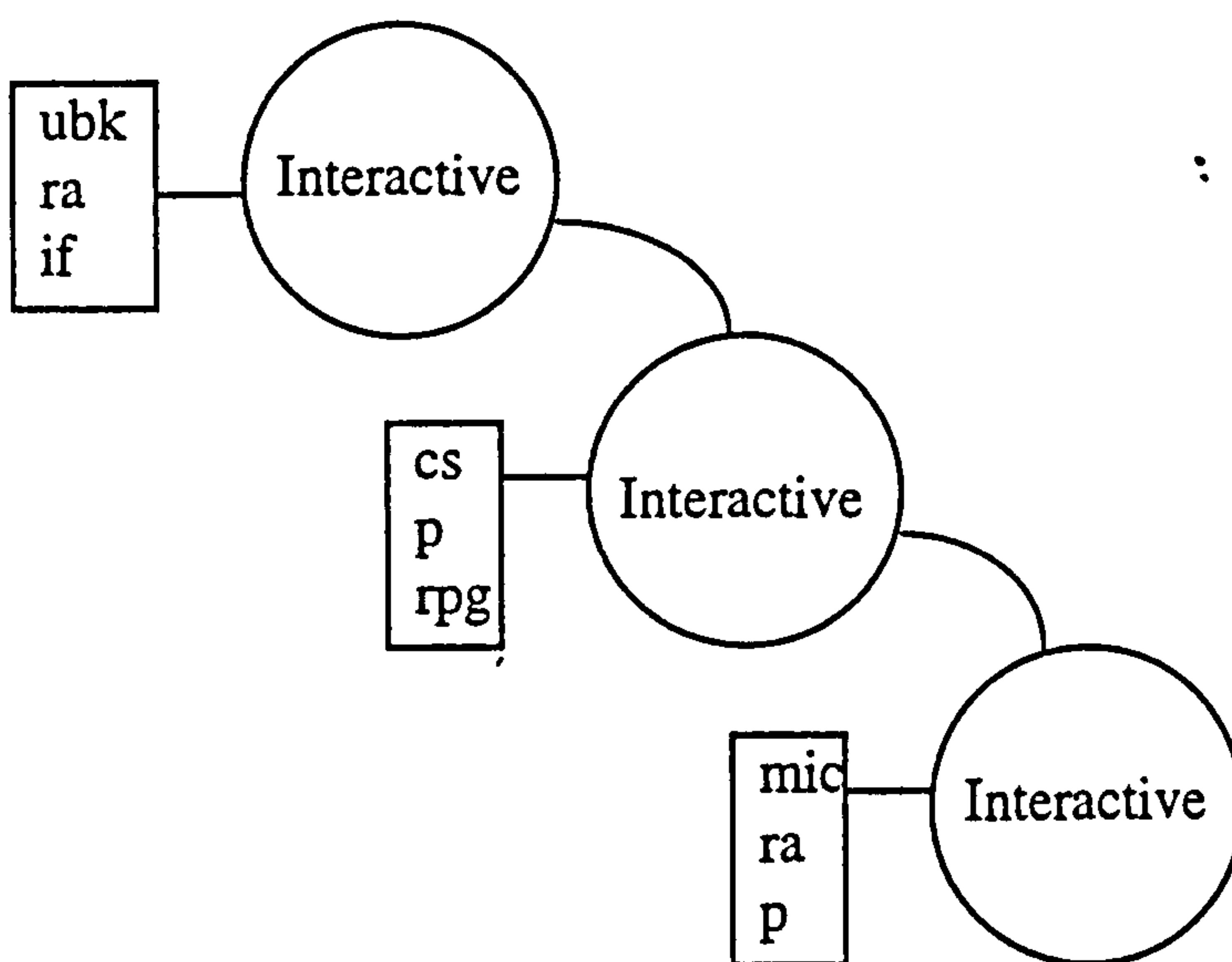


Figure 5.15. The overall sequence of comprehension strategies used by SI3

A three stage assignment of strategy use characterizes SI4's reading processes reflecting an interactive approach with a limited variety of top-down and bottom-up strategies. The only common strategy used is paraphrasing in the last two stages of employing reading strategy.



**Figure 5.16.** The overall sequence of comprehension strategies used by SI4

The sequence of strategies observed in SI5's protocols reveals an interesting chain of reading strategies which begins with an interactive approach and ends with purely bottom-up processing. The massive use of reading strategies at the initial stage probably reflects one's individual style. However, the shift of approach from an interactive to bottom-up strategies indicates subject's having problems with lower level processing of the text.



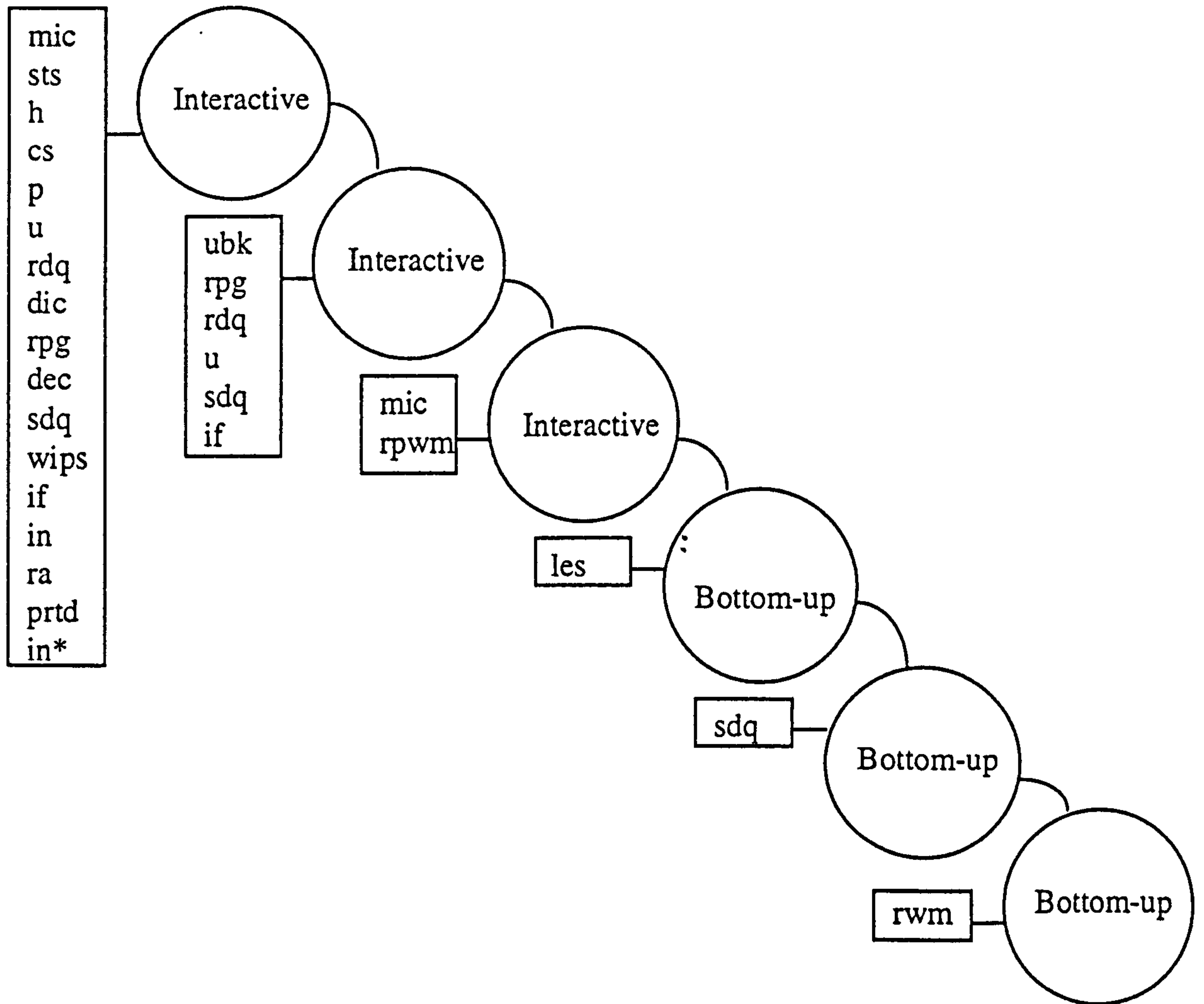


Figure 5.17. The overall sequence of comprehension strategies used by SI5

In like manner, SI6 uses quite a few number of reading strategies at the initial stage which soon loses weight after the second stage of comprehension processing.

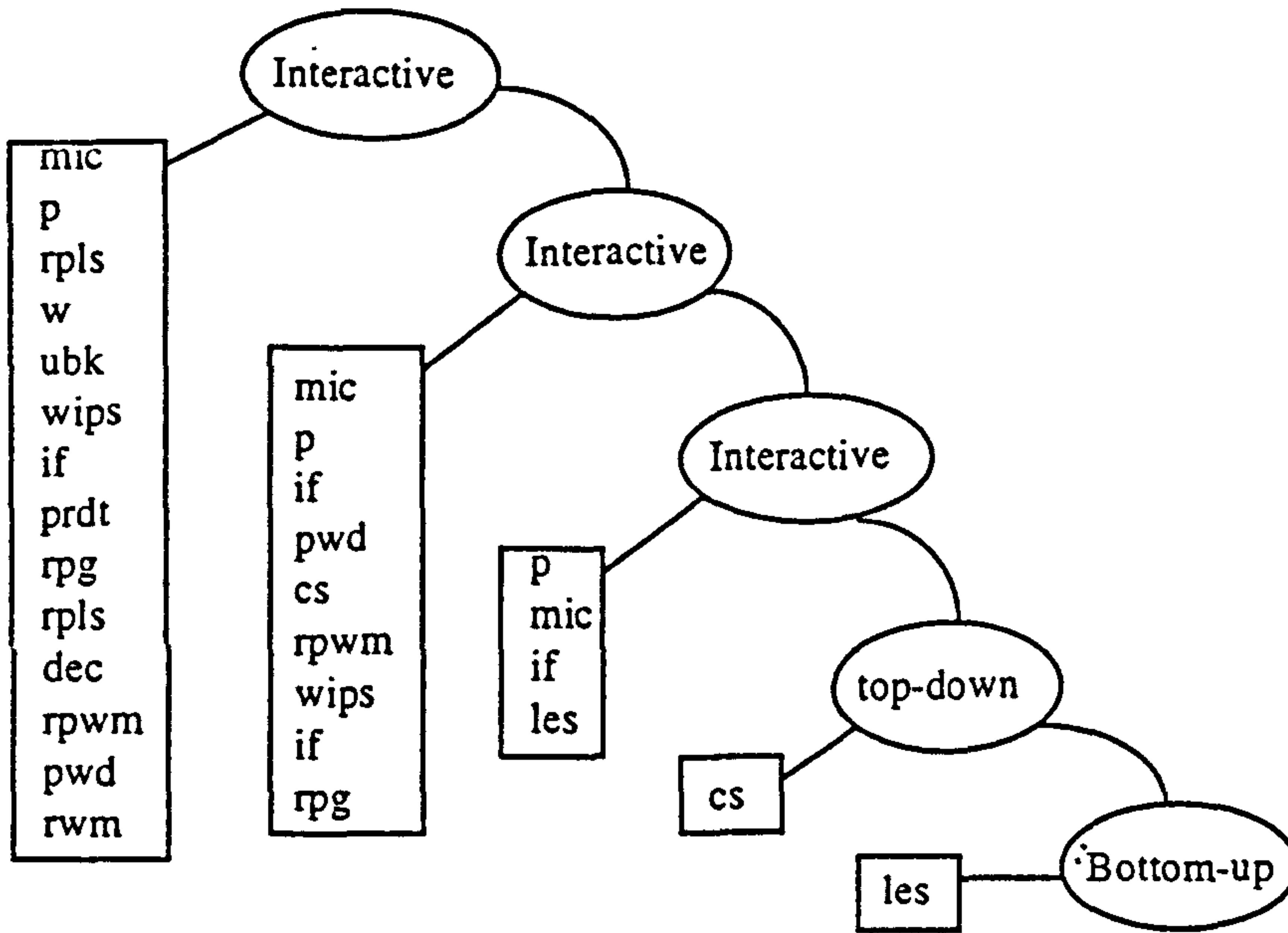


Figure 5.18. The overall sequence of comprehension strategies used by SI6

Like SI3 and SI4, SI7 resorted to as few stages of tackling reading comprehension as possible. Like SI6, his main pre-occupation with the text presents itself in the initial stage wherein a lot of reading strategies are used.

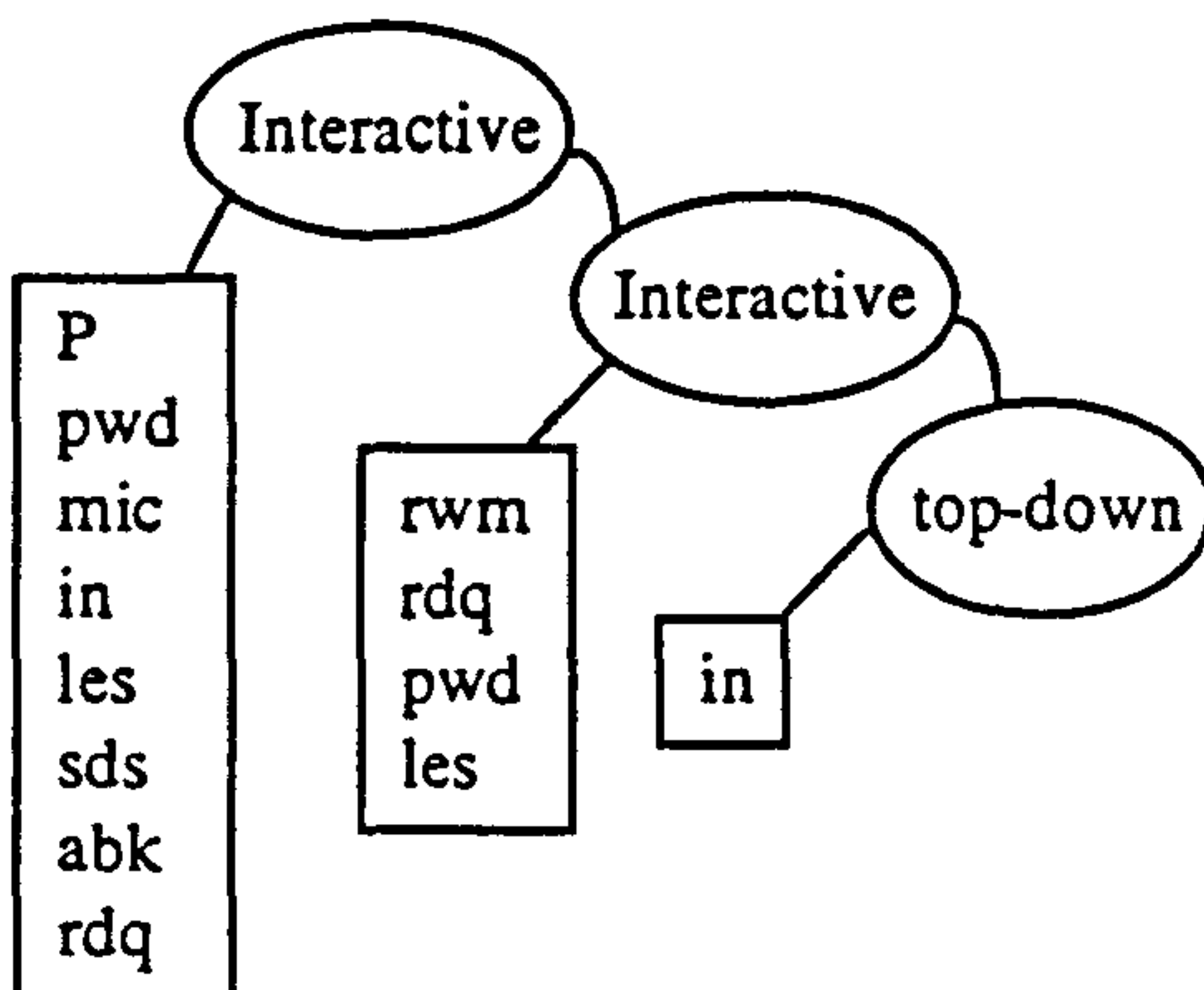


Figure 5.19. The overall sequence of comprehension strategies used by SI7

This stage is characterized by the use of paraphrase and paraphrase with deletion strategies. As to the reading comprehension model employed by the subject, his approach reveals a constant use of both higher-order and lower-order strategies. It is only in the last stage that he employs a single inferencing strategy to tackle comprehension problems.

SI8 used the least number of strategies among the skilled readers reported so far (i.e. 38 strategies). He did not show interest in doing the experiment and left many of the sentences unprocessed.

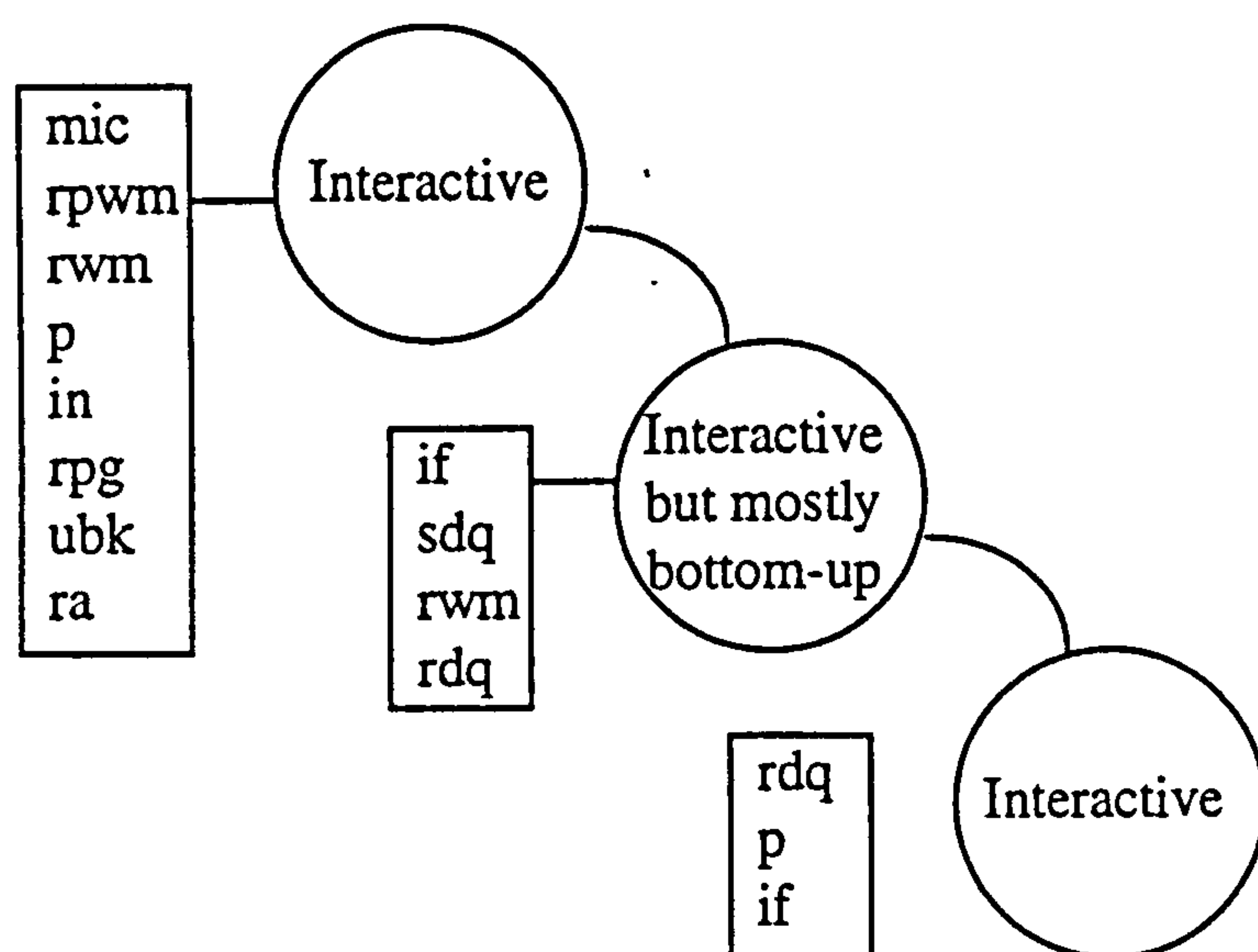


Figure 5.20. The overall sequence of comprehension strategies used by SI8

He reasoned that the text was not suitable as far as his expertise was concerned. It is possible to assume that one important factor which caused him not to be



cooperative (or to spell as many thought processes as he could in verbalizing the text) was his deficiency in language proficiency reflected in his lack of desire to show his understanding of the text. In fact, he got the lowest score in TOEFL compared to the rest of the skilled readers. His justification revealed in his retrospection report shows that although his verbalization indicates his problems with the text, he insisted that the text was very easy to cover up his dormant knowledge of English.

To sum up, evidence for interactive approach come directly from the initial observation of the strategies used by both the novice and skilled readers. All readers showed working at all levels of text processing including top-down strategies such as using prior knowledge, a range of monitoring strategies, making inferences and discourse processing as well as bottom-up processing involving word recognition, phonemic/graphemic decoding, and syntactic processing. In comparing both the skilled and novice readers' strategies, it could be observed that the novice readers' protocols are devoid of global processing at discourse level. Probably allocation of more processing space due to skill deficiency at grammatical and word identification and problem in automatically processing words and syntactical structures leave less space for them to process the text at the discourse level.

The skilled readers' protocols, on the other hand, exhibit lack of processing at syntactic level. It could be speculated that the skilled readers due to higher language proficiency are adept at processing the syntax automatically and this automaticity frees some processing space in their short term memory to deal with global aspects of the reading material.

By and large, the following arguments could be raised by observing the novice readers protocols:

- a) an interaction of reading strategies from top-down to bottom-up is observed. On the whole evidence for the use of an interactive approach was noticed;
- b) however, while some subjects were more inclined to use top-down interactive approach such as NI1, NI2, and NI8, some inclined to employ bottom-up interactive such as NI3, NI7, and the rest used a dominant interactive approach such as NI6, NI5, and NI4;
- c) different number of reading strategies were used by the readers to the extent that almost no one subject used the same number of strategies as the other ones;
- d) variation in using reading strategies within each stage of the readers' protocols shows an amalgamation of reading strategies unique to each individual reader.

The skilled readers generally showed that they used all possible source of text processing in dealing with text comprehension. Their approach for the most part

is interactive. However, the reading processes of SI2, SI5, and SI6 show that the subjects used more bottom-up approach as their final resorts to solve comprehension problems. This could be viewed within an interactive compensatory approach. It could be speculated that the readers compensated for their deficiency in solving comprehension problems through top-down strategies by resorting to bottom-up strategies. Another important feature of the skilled readers text processing is their use of a large amount of top-down and bottom-up strategies particularly at the early stages of the reading process (see for example, SI2, SI3, SI5, SI6, and SI8). However, as they delve further to solve comprehension problems they become more selective and therefore pick up certain fewer strategies. A third important characteristic of the skilled reading process is automatic processing. Unlike the novice readers, many of the sentences were automatically read and consequently left no trace in their verbalization.

A quick examination of the reading process of the skilled and novice readers shows that each individual reader employs his/her own pattern of reading comprehension strategy. Readers apparently use a unique combination of reading strategies both within each stage of reading comprehension as well as across reading strategies. The readers combined various interactive components of the reading process in different ways. Furthermore, some strategies were used by the readers which suggest the occurrence of common reading strategies. However,



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none of the strategies employed show a systematic approach in which certain strategies follow certain other strategies if and only if certain conditions are met. This in fact weakens the possibility of teaching step-by-step reading strategies to the novice readers.

### **5.5. Problems Observed In Applying The Think-aloud Technique**

The protocols of some of the readers showed that certain methodological problems were disclosed as a result of using the thinking-aloud technique. The problems discussed in this section were not accounted for in the analysis of the protocols and include text-task interaction, and social/psychological factors.

#### **Text-task Interaction**

The data obtained from N11's protocols show an interaction between text processing and task execution. There is then the possibility that some time intervals between each verbalization are more due to this interaction than to real processing time. In verbalizing S23 of T2 she says:

*/I don't know what is wrong with my pauses/ I would certainly read this phrase 'in other words' much quicker if I were reading for myself/ but I paused here inasmuch as I wanted to report and explain all these to you/*

This assertion is obviously an indication of level 3 verbalization which was accounted for in chapter 3 under the subtitle of Effects of Task on Verbalization. The distorting effect of reasoning and explaining cognitive processes as was predicted by Ericson and Simon's (1993) model of verbalization can be readily seen in the readers' pauses and reading pace. Instances of text-task interaction were also found in the protocols of NI4 who reported an interaction between text processing and task execution which caused her to lose concentration. She says:

*/now since I am supposed to tell you everything/ I am still thinking about what we talked to each other / it takes time/ you know/ to concentrate my mind/*

NI8 also reports the interaction between text processing and task execution tracing his comprehension failure to his losing concentration:

### Text 3

### Protocol

S43: Much laboratory work is justified on the basis of providing insights that will have medical or agronomic applications.

*/again/ cause I was thinking to the explanations I gave to you I lost my concentration/*

This effect is not, however, accounted for in Ericson and Simon (1993) verbalization model. Regardless of the methodological factors influencing the process of verbalization at least among the novice readers of this study, one would have to give a thought to the relation of the language proficiency and memory

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capacity. Put simply, the better the language proficiency, the greater the capacity for memory to be used for verbal reports.

### Socio/psychological Factors

To explain one's thought in a think aloud session is to expose one's ability as well as inability to the outside world. Pleasing the researcher by saying that one has understood a sentence or a phrase when this is not so is one way of protecting oneself from outside judgment. Regarding this, NI4 tried to please the researcher by saying that she understood the text. In fact, her think-aloud data were not in accord with her claims and showed frequent confusion in understanding.

Another social/psychological factor in verbal report experiments is checking the outcomes of one's own understanding against an internal measure of completeness and accuracy. The judgment is reinforced by the presence of an outside observer (here the presence of the researcher). Somewhere during his text execution, SI7 said:

*/When I read this text/ I check how fine I understood and explained the things I read/ It is always in my mind/ I think of you/ your judgment about me/ what you think about what I say/*



Indeed, this latter statement is an important issue in think-aloud studies. I know of no studies that have examined the extent to which this might influence the comprehension processes.

### Section III

#### 5.6. Quantitative Results

Based on the hypothesis made earlier in chapter 2, it was assumed that there is a positive relationship between number of strategies used by the novice and skilled readers and their TOEFL scores. But, in fact, correlating the number of reading strategies with the novice readers' TOEFL reading component scores based on the Pearson Product-Moment correlation formula, an inverse correlation was obtained ( $r:-0.53$ ;  $p:0.90$ ) that shows (table 5.3.) reading strategies make a negative non-significant relationship with language proficiency.

| Subject | r     | P    |
|---------|-------|------|
| Novice  | -0.53 | 0.90 |
| Skilled | 0.002 | 0.83 |

**Table 5.3. Correlation coefficients between number of strategies and TOEFL scores of the novice and skilled readers. r: correlation coefficient; p: probability**

Different reasons can justifiably be attributed to the above data. A) the small size of the sample: since the number of reader informants taking part in this study was

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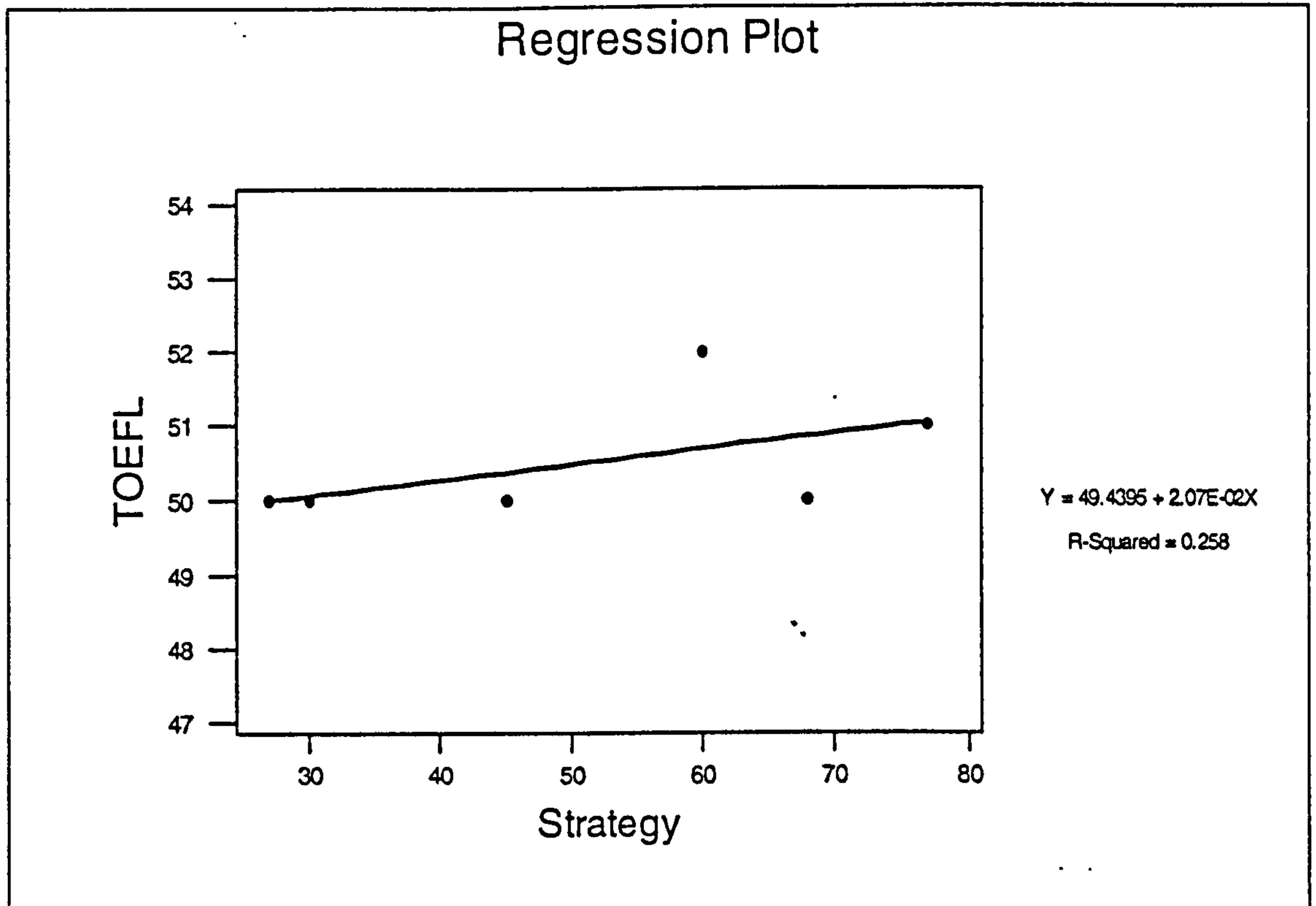
restricted, it was to be expected that this factor should reduce the value of the correlation. B) the normal distribution of the scores and strategies: the presence of an extremely high and an extremely low score on the strategy and language proficiency variables with little in the middle has affected the correlation coefficient. The data revealed by NI1 with the highest instances of strategy use (i.e. 129) and the lowest TOEFL score among the novice readers (i.e. 27) at one extreme and NI8's lowest contribution to the strategy use (i.e. 37) with the highest TOEFL score (i.e. 40) among the novice readers at the other extreme indicate that the normal distribution of the data is affected by these extreme scores. These two extreme poles of strategy use and proficiency scores reveal an interesting aspect of the possible relationship between the two variables. It can be postulated that the higher the novice readers' use of strategies is, the lower their reading proficiency scores are. We may relate this relationship to the subjects' use of unsuccessful reading strategies such as repeating to retrieve word meaning and word for word translation. In other words, the higher the use of ineffective strategies is, the lower reading proficiency score can be expected. Therefore, what can be counted as an important factor in interpreting the inverse correlation between the two variables pertains in fact to the *type* of the strategies used to tackle the reading for meaning task, on the one hand, and the number of strategies containing these ineffective uses on the other hand. Obviously, the novice readers due to employing some such reading strategies underline their status of being below average readers as

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shown in their reading proficiency test. One implication of the correlation above might be the contention that probably what counts as an important factor in successful reading comprehension is not how many reading strategies are used but rather how effectively and appropriately reading comprehension strategies are employed. If this is the case, then one would expect greater attention to be devoted by the readers to improve the quality of the reading comprehension strategies rather than the quantity of the strategies.

However, in the case of the skilled readers the correlation coefficient was found to be a low non-significant relationship too ( $r: 0.002$ ;  $p: 0.83$ ). However, in contrast to the results obtained from the novice readers it is not a reverse correlation. Probably the most important factor influencing the correlation can be attributed to the small number of the subjects participating in the present case study. Moreover, two unusual observations in the data were noticed in the above correlation. The two observations relate to SI7's low number of strategies (i.e. 29) and his highest proficiency score (i.e. 58) among other skilled readers and SI6's highest number of strategies and his good proficiency score (i.e. 53). Excluding these two observations as outliers from the data, another correlation was run. This time, the correlation showed that there is a rather positive relationship between the number of strategies and gains in language proficiency (see the regression plot below) .





**Figure 5.21. Regression plot between number of strategies and proficiency gains of the skilled readers**

However, in general, as to the relationship between the number of reading strategies and the levels of reading ability, the descriptive statistics showed that there is no significant difference between the means of the strategies used by both group with a T value -0.32 and a high probability of 0.76. What seems to be evident in the t-statistics shown in table 5.4. below is the fact that number of strategies cannot be considered critical in distinguishing a novice from a skilled reader. In comparing good and poor reading comprehension, an important element which must be taken into account at this juncture is an

examination of *types* of problem-solving strategies poor and good readers employ rather than merely the *number* of strategies.

| Subjects | Strategy* |      | Language proficiency score** |      |
|----------|-----------|------|------------------------------|------|
|          | Mean      | std. | Mean                         | std. |
| Novice   | 53.6      | 30.4 | 33.50                        | 4.3  |
| Skilled  | 58.3      | 22.6 | :51.75                       | 2.76 |

**Table 5.4. Mean comparison of strategy and language proficiency score of novice and skilled readers.** std.: standard deviation; \* (T: -0.32; P: 0.76); \*\* (T: -10; :0.001)

An examination of the number of strategies seems to be suitable when an investigator wants to know which strategy is mostly used by either group. However, there is a significant difference between the means of the language proficiency scores of the novice and skilled readers (P: 0.001).

## 5.7. Summary

In sum, based on the data model analysis described in chapter 4, the reading protocols of the reader informants of this study were analyzed and a series of reading strategies was identified and discussed based on two main categories of higher-order and lower-order processing. Comparison of components of the reading process showed that the skilled and novice readers were distinguishable in

terms of the number of uses of metacognitive, inferencing, discourse processing, word recognition, and syntactic processing strategies. Although the protocols of both groups of readers showed they used an amalgamation of the reading strategies in their text processing, certain categories of reading comprehension were absent in their protocols. For instance, novice readers revealed no text processing at discourse level. The skilled readers on the other hand, did not use syntactic processing in their approach to text processing. Monitoring statements by the skilled and novice readers showed that the occurrence of processing difficulty at word level is higher among the novice readers than the skilled readers. On the other hand, the skilled readers showed more processing engagement at sentence level than at word level.

So far a multitude of reading strategies from bottom-up to top-down strategies were observed to be used by both groups of the reader informants in this study, and this provides evidence for the proposed theory of ESL reading as an interactive process.

In comparing the strategies of the novice and skilled readers, and to respond to the hypothesis proposed in chapter four concerning identifying strategies used by each group of readers, it was found that the total number of strategies employed by the novice readers is 170 which makes up almost 39.5% of the total



429 strategies. This means that at least 39.5% of the strategies used by the novice readers were those which were not shared with the skilled readers. On the other hand, 54% of the total 487 strategies were only used by the skilled readers. To provide an answer to the question of individual differences in reading, a detailed analysis of each subject informant's protocol data was carried out to examine the extent to which the readers used similar strategies in their approach to reading comprehension. The results showed that almost each subject used his/her own pattern of reading strategies which reveal individual inconsistency in processing style. The quantitative analysis of the data could not provide evidence for the hypothesis that there is a positive relationship between the number of strategies employed by each group of the readers and their language proficiency scores. Non-significant results were obtained in the comparison of the mean of the reading strategies used by both the novice and skilled readers.

Chapter Six

Conclusion

# CONCLUSION

## 6.1. Introduction

This chapter mainly deals with reporting a summary of all chapters and sections of the study. In light of the findings of the study, it then examines pedagogical, theoretical, and methodological implications of the study.

## 6.2. Summary

The purpose of the study was to identify and classify reading comprehension strategies between two groups of skilled and novice foreign language readers by employing think-aloud protocol methodology. The selection of poor readers was basically justified on the grounds that little is known about what they actually do as they read, their strengths and weaknesses, and how their reading is different from that of proficient readers. The study thus began with a qualitative approach to reading in English as a second language between two groups of Iranian novice and advanced readers. From the initial pilot study administered to two groups of skilled and novice readers, the main hypotheses of the study were formed. It was hypothesised that poor readers in this study would employ a smaller number of reading strategies due to lower second language reading proficiency. Readers' use of an interactive approach to text comprehension was also determined. Furthermore, the study examined the



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issue of the individual differences among both the skilled and novice readers within an adapted framework of an information processing system.

However, no supporting evidence was found to confirm the first hypothesis. Getting insight from previous developments in interactive theory a response classification scheme was developed and the strategies were then classified into seven main categories; that is, prior knowledge, metacognition, inferencing, discourse processing, word identification, phonemic/graphemic decoding, and syntactic processing. Strategies used by both groups of the learners reveal that they all used a combination of bottom-up and top-down strategies and supported the interactive theory of this study. Further analysis of the reading processes of each individual reader within an adapted framework of human information processing system showed that the readers used a multitude of reading strategies which differed from each other.

### **6.3. Theoretical Implications**

Testing the hypothesis about the number of strategies between the novice and skilled readers, no significant difference was found to show that the skilled readers used a greater number of strategies than the poor readers. One possible line of research in this regard might be related to the function of the text. That is, future research should investigate whether strategy numbers can

be varied as a function of text by testing reading comprehension strategies with high to low-level knowledge texts as between novice and skilled readers.

No significant relationship was found between language proficiency and readers' strategies. One can argue that reader strategies do not determine proficiency, but are permitted by it. The use of reader strategies may not lead to higher accomplishments, instead one of the benefits of higher proficiency may be the capacity to use a wider range of strategies as was observed in the case of the skilled readers in this study.

Within the interactive reading theory postulated so far, the most fundamental characteristics of interactive models suggest some potent sources of individual differences. Based on the findings, it can be said that reading comprehension in the context of English as a second/foreign language as investigated in this study is generally an activity in which individuals exhibit considerable differences in the reading strategies which they bring to text comprehension. The findings of this study support theories of individual activity (e.g., Sarig, 1987) in which different individuals apply different reading strategies based on the different background experiences they bring to the reading comprehension process. Therefore, the assumption of homogeneity among groups of readers for whom English is a second language is unwarranted. We do not really know whether

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some elements of the text processing and the use of reading strategies used by the novice and even skilled readers in this study were merely cases of transfer of skills in the first language to the second language.

There is probably a measure of truth to all plausible interactive processing orientation as far as individual differences are concerned. An important feature of the reading comprehension strategies observed in the protocols of NI5, NI6, NI7, NI8, SI2, SI3, SI5, SI6, and SI8, is the use of a greater variety of reading moves at earlier stages of solving comprehension problems. It might be the case that as more information is explicitly represented at the time of initial understanding, less processing effort is required for subsequent use. An important point in this regard is that no individual reader used a similar combination of strategies either at the initial or at the final stage of their text processing.

This also provides the language teacher with information about whether certain reading comprehension strategies can be taught to the novice readers. The implication is that based on the observed variation of the strategies seen in the different stages of reading processes employed by the novice and skilled readers the role of the language teacher must be to facilitate language learning.



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Many of the reading strategies found in this study provide counter evidence for the current theories of reading as a top-down approach. The skilled readers' engagement in many word identification and bottom-up strategies refute the governing notion in top-down models which characterize skilled reading as higher level skills such as the prediction of meaning by means of context clues or certain kinds of background knowledge at the expense of such lower-level skills as the rapid and accurate identification of lexical and grammatical forms. The strategies particularly by the ESL skilled readers showed that reading is not a psycholinguistic guessing game as Goodman (1967) characterized it. The skilled readers frequently resorted to such bottom-up strategies as L1-equivalent search and word identification based on phonological similarity.

Over-reliance on certain top-down strategies by the novice readers provides supportive evidence for Carrell's (1988) notion of knowledge-based processing or schema interference. Carrell found that bi-directional text processing and over-reliance on one or the other mode of processing in turn may result in comprehension problems. Evidence of the novice reader's over-reliance was observed at least on two occasions; over-relying on content schemata revealed in the protocols of NI5 and almost all novice readers' great use of repeating to get word meaning. Different factors have been accounted for by Carrell as the causes of such bi-directional processing including, schema availability and

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activation, skill deficiency, misconception about reading, and individual differences.

What we have for the time being as evidence is that the novice readers' over-reliance on using top-down strategies shows deficiency in linguistic knowledge due to their low language proficiency score. Such an over-reliance could not compensate for the deficiency at the lower level. Normally, such a utilization can be observed to be a characteristic of poor reading comprehension wherein deficiency in linguistic knowledge pushes the reader to compensate for the gap in either way (c.f., Ghonsooly's work, 1993 on schema utilization in L2 listening comprehension). In either case, language proficiency and better linguistic knowledge is the key to better information processing while activating background knowledge. A more balanced view is held when top-down processing is applied to a text whose grammatical structures are known to the reader. While pre-reading activities are crucial in activating learners' background knowledge for further text processing, greater attention must be paid to upgrading the learners' grammatical ability since lack of this knowledge was shown to be the triggering factor in mal-adaptation of background knowledge observed in the protocols of NI5 and NI7<sup>1</sup>. Concerning other factors mentioned above (i.e. schema activation and

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<sup>1</sup> See chapter 5

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misconception about reading), we do not really know if they have had any influence on such bi-directionality of reading process. In fact, each of the above factors should be systematically investigated to see their plausibility.

The use of some reading strategies such as paraphrasing, main idea construction, predictive recognition of text development, and identification of comparison/contrast reflects the readers' conception of the reading task, habit, and techniques to enhance comprehension which lack the property of *problematicity*<sup>2</sup> invites the assumption that they might not fit within the general theory of reading as a pure form of problem solving activity in which they are regarded as clear solution strategies. They rather seem to be more like what Simon (1973) calls 'fuzzy, ill-structured problem[s]'. Reading problem-solving strategies were actually used only when they detected problem/s in comprehension.

The study of reading comprehension strategies is difficult. The great bulk of such strategies employed mainly by the skilled readers provide problems and limitations for the more or less explicit models of strategy analysis in problem solving and decision making. These so-called strategies do not seem well characterized by pure problem-solving theory in which means-ends analysis and

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<sup>2</sup> See chapter 1 for a definition of reading strategies.



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hypothesis testing are clear solution strategies. Our readers engaged in substantial problem solving for a variety of purposes. However, the skilled readers appeared to use more strategies that could not be interpreted as strategies arising from problems in comprehension. These were rather strategies which were used to enhance comprehension. The novice readers were, in contrast, more prone to pursuing a model of problem solving.

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Some of the reading strategies were speculated to be *transferred* from first language to second language such as 11-equivalent search. However since most ESL reading models adapt first language theories due to a huge quantity of research in English as a first language as compared to far fewer investigations in reading English as a second language the place of such a process is not known in the ESL interactive models of reading. As Grabe (1988) complains, we do not really know how second language interactive reading models account for the process of transfer. This is an area which requires more investigation into examining both first and second language of the readers of this study to determine the extent of such influence on the readers' use of reading strategies in English as a second language.

The results also provide supportive evidence for the reading universals hypothesis that suggests that there are some forms of common reading processes

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underlying different languages. The novice and skilled foreign language readers of this study appeared to be employing similar basic metacognitive and monitoring strategies to what was used by other non-native novice and skilled readers of English (cf., O'Malley and Chamot, 1990; Wenden, 1985). For example, the subjects' think-aloud data showed that the great majority of their vocabulary problems were with the so-called semi-technical items (c.f., Cohen et al., 1979). Another item of evidence is the number of word-related difficulties testified to by almost all the novice readers (c.f., Laufer and Sim, 1985). Furthermore, insensitivity to contextual information exemplified in repeating to retrieve word meaning (c.f., Ryan, 1981) and L1-equivalent search (c.f., Krings', 1987 use of 'potential equivalent retrieval strategy', P:169) were two more reading strategies used by the novice readers in this study. These common elements of strategy use among Persian language users having different cultural and orthographic language systems weaken the hypothesis that second/foreign language learners from different language backgrounds employ different strategies due to different orthographic and cultural differences. This being so, we can lend support to the framing of common, cross-cultural syllabuses for teaching reading in the context of English as a second/foreign language.

One aspect of the findings, however, has until very recently received little attention. Reliance on the last few sentences of the text has to be systematically

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investigated in the literature of main idea construction. What seems to be interesting about this is the subject's conception about his memory capacity and the construction of a main idea. The subject's attempt to construct the main idea seems to be more influenced by his awareness about his processing capacity than the real requirements of the task of main idea construction. I think further investigation of the phenomenon is warranted. Obviously, a successful approach to main idea construction is to keep all important elements of a paragraph in mind. This could be done by highlighting them and a quick review to make a list of all the important elements.

Some more interesting data cannot be accounted for by existing models of text processing and problem solving. Some readers reported that they were on the verge of 'failure' and attributed their difficulty to one thing or another. The following are some examples of this when NI3 says:

**/ I can no longer read the sentence/ I can't read the sentence as soon as my eyes fall on these two words/ cause I feel I don't know these two words and consequently I am unable to read it/**

**/possess/ possess/ 08/ I don't know what it is / I am confused/**

Although the majority of these statements belong to the novice readers, it seems noticeable that some skilled readers also revealed such statements. As



Johnston and Afflerbach (1984) propose, the time has probably come to integrate these attributional/affective components into problem solving models of reading comprehension.

In response to Block's call (1986) to identify different sorts of reprocessing strategy, this study identified different kinds of reprocessing strategies namely, reprocessing to retrieve word meaning from LTM, reprocessing to assemble, reprocessing to get the gist, and reprocessing long structures. In at least two of the strategies i.e. reprocessing to assemble and reprocessing long structures, a strong element of word for word bottom-up processing to derive meaning from the sentence accompanied by limitation in short term memory could be seen.

What seems clear is that better bottom-up processing can allow greater space in short term memory to be devoted to further text processing. The implication of this for the novice readers in this study is that word for word reading can impede comprehension of the text since, as previously observed, by the time the reader had reached the end of the text, he might have forgotten what it was all about.

The novice readers must be informed about this and remedial teaching of reading for the meaning chunks must be employed.

At least one reading strategy (i.e. paraphrase with deletion) was observed to be influenced by the requirements of the verbalization procedure in which thought

processes in reading comprehension as a receptive skill are to be verbalized in a spoken mode. It was hypothesized then that certain strategies might be the result of verbal interpretation of written discourse in which the subject interprets the text in a verbal or spoken manner. If this assumption is correct, then the damaging effect of transferring spoken discourse strategies to interpretation of written discourse must be seriously taken into account. Ericson and Simon's models of verbalization (1984; 1993) do not account for this.

Data obtained from the reader informants in this study showed that as was instructed the majority of the verbalizations fell in levels 1 and 2 in which the readers reported the information being immediately processed. Nevertheless, instances of level 3 verbalization were observed in the novice readers' text execution. Of the three instances of this, two were related to an explicit assertion of text-task interaction in which the readers complained about the interaction between concurrent verbalization and text execution as deterring factors in their normal pace of reading comprehension. Such verbalizations can assist language teachers in understanding why certain processes were used by his learners. It specially assists the language teacher to become familiar with the way his learners justify their decisions at times when comprehension goes awry. However, it is suggested that employing think-aloud at this level is to be

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practiced in class situations only for better understanding of the learners' ideas, hypotheses and their motives. Therefore, due to the possibility that such processing at level 3 verbalization may change the course of cognitive processes (i.e. verbal reports may not be the exact information present in STM at the time of verbalization) care must be taken when it is used for the experimental purposes.

Two of the subjects expressed problems in executing the task which appeared to be the result of the experimental environment. This may cause problems for studies of think-aloud nature whereby the subject due to the presence of an outside observer (i.e. the think-aloud researcher) may provide erroneous reflections on the data by statements such as 'ok, I got it', or 'this sounds ok' with the purpose of convincing the outside observer that comprehension is going smoothly. This seems to be more prevalent in the case of the adult novice learner who is more prone to failure and therefore more sensitive to exposing his/her weaknesses to the outside world. One way, however, to safeguard the accuracy of the verbal reports is through retrospective accounts wherein the subject may be asked further questions about what seems to the researcher to be an artificial product of thought processes. Another possible solution in recording accurate verbal reports is assigning an observer who is known to the subject informant (See Cohen and Manion, 1980 for a discussion of multi-



method approach to research). This might reduce the possibility of maladroit, faulty verbalization.

It is also possible to argue that reading comprehension is not a one way road towards solutions wherein the subject employs a series of reading comprehension moves to tackle failures in comprehension. Reading comprehension process, particularly when examined through verbalization, cannot be seen as a phenomenon detached from social, psychological and affective factors which in one way or another may exert influence on the process of understanding. One important issue in this regard is examining the extent to which these factors might influence reading processes in the context of verbal report investigations.

#### **6.4. Instructional Implication**

Analyzing the protocols, a number of implications for ESL reading research follow from an acceptance of interactive models. First, since within an interactive theory bottom-up processing is as important as top-down processing and basic to successful good reading, great attention must be paid to teaching rapid context-free word and phrase recognition, extensive vocabulary development and syntactic pattern recognition. Second, other studies done in the field of ESL reading (see for example chapter 2) generally confirm the extent to

which second language readers need to develop a massive receptive vocabulary that is rapidly, accurately, and automatically accessed. This last point deserves more attention as far as reading instruction is concerned. Learners master complex cognitive skills by concentrating processing energy on to-be-mastered subtasks, which once mastered, require relatively little amounts of processing capacity, thereby freeing up the system to work on the mastery of other subtasks (McLaughlin, 1987a). A poor second language reader needs to exert considerable cognitive efforts to realize a correct phonetic expression of individual words and at the same time employ appropriate syntactic rules. Each of these processes is developmentally linked to each other to the extent that mastery in one task may facilitate mastery in the other. Automated word-decoding allows space in working memory for retaining other higher processes. Therefore, it is not surprising to see one important higher processing skill namely, discourse processing, is lacking in the protocols of the novice readers. Poor readers' slow processing of words and non-automatic symbol-sound matching exemplified in their strategies (such as word for word translation, L1-equivalent search, word identification based on phonological similarities, integrated decoding), and their extra occupation with identifying syntactic structures all hampered them in processing at discourse level. *Automatization* of basic skills such as word decoding should be given importance in developing course designs and instruction method for the

readers of this study. It goes without saying that one important characteristic of skilled readers is their speed in word recognition and reading which is the result of automatic processing of the reading material.

However, acquisition of knowledge and in our case developing vocabulary knowledge is not something to be acquired within the classroom situation only. It can also be achieved by extensive reading over time. Thus, the view that 'practice makes perfect' must hold as far as reading instruction is concerned. Third, interactive models do not downgrade the importance of higher level processing such as discourse processing, using background knowledge and the rest. It is, therefore, very important that some time be devoted to such top-down concerns as reading for global meaning.

Fourth, the issue of *individual differences* implicates the notion that probably no model of reading, as Eskey (1988) rightly contends, can determine what mix of strategies second language readers in general employ, let alone the mix for particular readers. The role of language instructor and material designer should therefore rest on developing fostering strategies rather than prescribing pre-determined strategies.



Fifth, an important component of the interactive reading theory is use of *metacognitive* processing which reflects knowledge about checking the outcome of any attempt to solve comprehension problems, monitoring the effectiveness of any attempted action, and testing, revising, and evaluating one's strategies for learning. An important variable in this regard is the assumption that the ability to execute successfully a reading comprehension task depends partially on subjects' knowledge about their memory capacity (exemplified in strategies such as in controlled skipping and in reprocessing long structures). The role of memory in text processing and the attitude of the learners towards what they perceive as the task requirement should be given more attention than before. It is noticeable that sometimes this conception is more influential in determining what is to be processed than how it should be processed. It is also noteworthy that subjects sometimes use different strategies to keep important information in mind which obviously shows their different conception of their memory capacity.

In short, integrating each new word with previously processed information means that the reader must have access to the results of earlier processes. If recently processed information could not be stored at least temporarily, the reader would be continually backtracking or rereading parts of even whole sentences and passages. In other words, one consequence of its sequential and

integrative nature is that skilled reading depends on the temporary storage of information while new information is being processed.

Novice readers do not seem to be successful in temporary storage of information due to the fact that they have to devote greater space in their workbench memory to execute fundamental aspects of text processing such as decoding. The readers, therefore, are to be informed about the importance of this factor in successful task processing. Having been identified as an important factor in text processing, the impact of memory on strategy use must be specified more in future research in reading comprehension as a second language. This obviously requires a closer collaboration between the applied linguist and the cognitive psychologist.

### **6.5. Methodological Implications**

The use of think-aloud methodology revealed important implications. It made it possible to identify groups of reading comprehension strategies as they occurred by the novice and skilled readers that seemed to be less identifiable by other on-line reading process exploratory methods. Through analysis of the verbal protocols a succession of basic strategies was identified which showed novice readers' attempt in applying different top-down and bottom-up reading strategies

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embodied in their model of the reading comprehension process<sup>3</sup>. The primary observation of this string of strategy use seems to be achievable through think-aloud protocol analysis that provides the investigator with one of the fascinating tools for observing mind processes.

Accordingly, while researchers use a variety of methods to identify learners' needs for pedagogical purposes, think aloud analyses of the way students approach a text can justifiably be used to assess their real needs. One famous method of needs analysis is the use of questionnaire. Although this technique may appear more manageable as far as analysis of the responses is concerned as yet it does not reveal a *real* profile of the target audience needs, because questionnaires ask learners to describe what they perceive as their needs rather than reveal what they actually do as they read. Use of a triangulation of methods seems to be one of the best options in enriching the think-aloud method.

Using think-aloud as a method of teaching and enhancing metacognitive knowledge and reading strategies is reinforced here. Thinking-aloud has begun to be put to use as an instructional instrument in first language research. For example, Hayes (1981 in Bereiter and Bird, 1985) used protocol excerpts as

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<sup>3</sup> see section 5.4.1.



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textbook material to explain, by example, problem-solving strategies. Palincsar and Brown (1984 in Bereiter and Bird) developed a reciprocal teaching method in which verbalized thoughts and questions by both teacher and students form part of cognitive learning. Moreover, Bereiter and Bird made an effort to examine thinking aloud itself as an experimental variable and to evaluate its effects on strategy use and performance. More recently Baumann, Jones, and Seifer-kessell (1993) used think-aloud to enhance children's comprehension-monitoring abilities. In fact, think-alouds require a reader to stop periodically, reflect on how a text is being processed and understood, and relate orally what reading strategies are being employed. In other words, think-alouds involve 'the overt, verbal expression of the normally covert mental processes readers engage in when constructing meaning from text' (Baumann, Jones, Seifert-Kessell, P:185). Nevertheless, the use of think-aloud as an instructional tool has not to the present researcher's best knowledge been practised in second/foreign language. The use of this methodology as a teaching method is, therefore, advocated in this study.

While thinking aloud can be used as a primary means of teaching English as a second language, it seems likely that modeling of on-line processes through thinking aloud would combine naturally with other approaches to reading instruction as well. For example, thinking aloud modeling would also be

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applicable to pre-reading activities (e.g., Au, 1977). By appropriate modeling, the teacher could not only activate relevant prior knowledge, but could demonstrate how skilled readers activate prior knowledge for themselves (Bereiter and Bird, op.cit.).

Process measures such as eye movement records and think aloud methodology would allow for individual difference analyses within experimental conditions. It would seem, then, that the sensitivity of good and poor readers to the kinds of task modifications employed within the prose learning paradigm should be investigated but with an emphasis upon individual difference analyses derived from separate indices of processing activity.

The objection of epiphenomenality, that is, the argument that there is no correspondence between verbal reports and cognitive processes (cf. Nisbett and Wilson, 1977) has to be rejected, at least with regard to data of this study.

Thinking aloud activity, as Ericson and Simon (1993; P:78) put it, is not entirely unfamiliar to every day life.

'...[A]lmost all subjects have probably had some experience of it before they come to the laboratory. Students at school occasionally have to explain their solutions of problems aloud to their fellow students in order to show how the solutions were generated. In other situations, people explain or describe their

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solution. attempts to others, so that the listener can tell them where their thinking is in error. Even more frequently, people just communicate their thinking to others'.

As time passes, the perspective of exploratory investigations using the on-line method of think-aloud becomes more attractive. Research in second/foreign language seems to rely increasingly on the findings of this method rather than on other reading process methodologies. The qualitative approach taken in this study aimed at providing more insights into reading strategies and process by the use of introspection in second/foreign language investigations. Nevertheless, the area of reading comprehension begs more exploration and one of the best means of achieving this seems to be through the think-aloud methodology coupled with other reading research methods.

## **6.6. Limitations of the Study**

Like any other scientific piece of work, the present study suffers from some limitations that may circumscribe the universality of the findings. The following are major limitations of the present study:

1. The respondents in this study did the task in the English language and reported on it in their first language. A possibility exists that recoding of the information might have caused some information to get lost as a result of limits



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in the respondents' memory capacity as well as other factors such as accuracy of translation of thought (Cumming, 1994).

2. The nature of the experimental passages suggests another limitation. The result of this study cannot be directly generalized to the materials which have different pattern of writing from the experimental passages in this study.

3. There is also another limitation concerning the external validity of the findings of the present study. As is commonly expected, like any other case study, the results of the present study cannot be directly generalized to any other population other than those for whom this investigation was carried out.

4. An examination of the extent of readers' success in using their strategies did not prove unproblematic. First, ambiguous verbal reports such as 'Oh, I got it' were problematic in this regard. In several occasions, this proved to be the result of social and psychological factors, that is, subjects did not tell the truth concerning their understanding of the text. As a result, such verbalizations could not provide the present researcher with valid information as to the success of the strategies used as a consequence of such statements. Second, many of the protocols showed only a partial interpretation of the text, leaving the researcher to wonder if the verbalized parts were automatically and

therefore successfully processed or simply they were the result of social and psychological factors mentioned above. Use of a triangulation of methods seems to be one of the best options in clarifying and therefore supporting the success of the strategies. Nevertheless, as can be seen from the analysis of this study much has been achieved.

**PAGE  
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## APPENDIX. A

List of readability questions asked from EST teachers based on Carrell's recommendations:

1. Do you think the texts are promising as far as the interests of the subjects in this study are concerned? By interest is meant whether the texts raise the motivation of the subjects to complete the task. Yes ( ) No ( ).

2. On the basis of your familiarity with the subjects in this study, do you think that the texts are of any relation to the subjects field of study, that is, Biology? Yes ( ) No ( ).

3. Do you think that the grammar or syntax of the texts is appropriate for the subjects? Yes ( ) No ( ).

4. Do you think that lexical choices of the text are suitable for the subjects? Yes ( ) No ( ).

5. Do you think the distribution of quasi-technical vocabularies, and non-technical vocabularies is justified in the texts? Yes ( ) No ( ).

6. Is the propositional density or the density of information available in the sentences of the text is suitable for the subjects? Yes ( ) No ( ).

7. Do you think the texts are generally appropriate for the subjects' level under the study? Yes ( ) No ( ).

8. Will you please express your reservations, if any, on the readability of the texts as far as the subjects of this study are concerned?

## Two Examples of Fully coded Analysis of Protocols: NI2 and SI1

### NI2 Protocol

(NB, for explanation of the symbolic figures used in the protocols see appendix C; see also NI2's sequence of comprehension strategies on page 284)

#### First Stage

S1/ 'plants characteristically synthesize'/ 04/ 'synthesize complex organic substances from simple inorganic raw materials'/ I reread the sentence to get the meaning of 'raw'/ {rpwm}

S3/ [(reads in RA mode)]/ 'possess'/ {rwm}

S5/ 05/ 'animals'/ 03/ 'on the other hand must obtain'/ 'obtain'/ {rwm}

S6/ [(reads in RLV mode)]/ 05/ 'lack'/ {rwm}

S7/ [(reads in RA mode)]/ 'feeders'/ {rwm}

S8/ [(reads the sentence in RA mode up to 'absorb')]/ um/ 'absorb'/ {rwm}

S9/ [(reads the sentence in RA mode up to 'dead')]/ 'dead and rotting'/ {rwm}

S13/ 'the problem is well illustrated'/ 'illustrated'/ {rwm}

S14/ [(reads in RA mode up to 'inside')]/ what does 'i e' stand for?/ {sdq}

S15/ [(reads the sentence in RLV mode)]/ 'least?'/ {sdq}

S17/ [(reads the sentence in RLV mode)]/ ok I reread it to get the gist/ {rpg}

#### Text2

S1/ [(reads the sentence in RLV mode)]/ I reread the sentence to get the gist)/ {rpg}

S2/ [(reads in RLV mode)]/ 'death is the necessary consequence'/ {in}

S3/ [(reads the sentence in RA mode up to 'individuals'/ 'individuals'/ {rwm}

S4/ [(reads in RA mode)]/ 06/ 'chance'/ {in}

S5/ [(reads the sentence in WFWT manner)]/ {wfw}

S6/ [(reads in RA mode)]/.....MT...../ what does it mean?/ {sdq}

S7/ 'obviously' / {in}

S8/ [(reads the sentence in RA manner)]/ 'maturity'/ {rwm}

S9/ [(reads the sentence and parses it in WFWT manner)]/ {wfw}

S10/ [(reads the sentence in RA mode up to 'features')]/ 'feature'/ {in}

S11/ [(reads the sentence up to 'parents' in RA mode)]/ 'identical'/ {rwm}

S12/ [(reads the sentence up to 'altered' in RA mode)]/ 'alter'/ {rwm}

S14/ [(reads the sentence up to 'term' in RA mode)]/ what does 'term' mean here?/ {sdq}

S15/ [(reads the sentence in RA mode)]/ 'survive'/ {rwm}

S16/ 'however'/ WFWT/ {wfw}

S17/ [(reads the sentence in RA mode)]/ 'evolutionary'/ {rwm}

Bottom-up  
Interactive

rpwm  
(F:1)  
rwm  
(F:13)  
sdq  
(F:4)  
rpg  
(F:2)  
in  
(F:4)  
wfw  
(F:3)

Bottom-up interactive approach used by NI2 as his initial attempt (i.e. first stage) to tackle reading problems. The box on the right of the protocols represents the type of the strategies as well as the frequency of occurrence of each strategy shown by the letter F. The circle on the top



of the box shows the overall reading approach of the reader at that stage. As can be seen from the protocols, some of the responses due to lack of verbalization are not present in the analysis. Also in order for the reader to be able to easily identify the reading strategies, each strategy is given a label at the end of each protocol shown in paranthesis.

Second Stage

**Text 1**

- S1/ 06/ 'raw material'/ {rwm}
- S3/ 'the plants can use this energy because they possess'/ {rpwm}
- S5/ 04/ I read the rest of the sentence to see whether I understand it or not/ {cs}
- S6/ I reread from the beginning of the sentence to get the meaning of the word/ {rpwm}
- S7/ several grammatical structures are used here such as 'feed'/ {ga}
- S8/ 'absorb'/ {rwm}
- S9/ 'rotting' {rwm}
- S13/ 'the problem is well illustrated'/ {rpwm}
- S14/ 03/ 'for example'/ something like this/ {if}
- S15/ 'least'/ {rwm}

Interactive

- rwm (F: 12)
- rpwm (F: 5)
- cs (F: 1)
- ga (F: 1)
- sdq (F: 1)
- if (F: 3)
- in (F: 2)

**Text 2**

- S1/ 05/ 'its survival'/ {rwm}
- S2/ 'consequence'/ {rwm}
- S3/ I should reread the sentence to get the meaning of the word/ 07/ {rpwm}
- S4/ I have to reread the sentence to get the word/ 09/ {rpwm}
- S5/ aha/ perhaps it refers to the prey/ {if}
- S6/ 'in other words' / {in}
- S7/ 'obviously'/ {rwm}
- S8/ 03/ 'maturity'/ {rwm}
- S9/ 'preceding' / {in}
- S10/ 'feature'/ {rwm}
- S11/ 03/ 'offspring'/ {rwm}
- S12/ I think 'alter' means to change/ {if}
- S14/ a period I suppose/ {if}
- S15/ 'survive'/ {rwm}
- S16/ can 'ancestor' mean supporter?/ {sdq}
- S17/ 'evolution'/ {rwm}

Interactive approach used by N12 as his second attempt (i.e. second stage) to tackle reading problems.

Third Stage

**Text 1**

- S1/ now I reread the sentence to see whether I got the meaning of the sentence/ {rpg}  
 S3/ 03/ I read the rest of the sentence to see if I can get the meaning of the sentence/ {cs}  
 S5/ 05/ 'obtain'/ {rwm}  
 S6/ does that mean not having<sup>^</sup>?/ {sdq}  
 S7/ ok I skip it and read the rest of the sentence to see what it says/ {cs}  
 S8/ / I reread from 'osmotrophic ones' to see if can get the meaning of the word/ {rpwm}  
 S9/ I need to look it up in the dictionary/ {dic}  
 S13/ 'illustrated'/ {rwm}  
 S14/ after all this explanation is not necessary and worth spending time on it/ I skip it/ {sts}  
 S15/ I read the sentence from the beginning to see the meaning of the word/ {rpwm}

Interactive

- rpg  
(F: 2)  
 cs  
(F: 8)  
 rwm  
(F: 8)  
 sdq  
(F: 1)  
 rpwm  
(F: 2)  
 dic  
(F: 2)  
 if  
(F: 1)  
 sts  
(F: 1)  
 in  
(F: 3)  
 wfw  
(F: 2)

**Text 2**

- S1/ 03/ ok I read it again to get the gist/ {rpg}  
 S2/ 'consequence'/ {rwm}  
 S3/ 07/.....MT...../ 'of old age'/ {rwm}  
 S4/ 09/ <sup>RLV</sup>'depends<sup>^</sup>/ {in}  
 S5/ I have to look it in the dictionary for its exact meaning/ {dic}  
 S6/ 'in other words<sup>^</sup>/ {in}  
 S7/ 'obviously'/ {rwm}  
 S8/ 04/ 'reaching'/ {rwn}  
 S9/ 'preceding'/ WFWT/ {wfw}  
 S10/ <sup>KA</sup>'feature<sup>^</sup>/ {in}  
 S11/ 'offspring'/ {rwm}  
 S14/ 'short term'/ {rwm}  
 S16/ probably it is like its previous ancestors/ {if}  
 S17/ 'evolutionary theory'/ WFWT/ {wfw}

**Interactive approach used by N12 as his third attempt (i.e. third stage) to tackle reading problems.**

Fourth Stage

**Text 1**

S5/ I reread the sentence from the beginning/ {rpwm}  
 S7/ 024/ 'feeders'/ {rwm}  
 S8/ 03/ I need to look it up in the dictionary/ {dic}  
 S13/ MT...../ I read the rest of the sentence to see if I can get it/ {cs}  
 S15/ 04/ I'd better use the dictionary/ {dic}

**Text 2**

S1/ 05/ 'unimportant'/ {rwm}  
 S2/ 'consequence'/ {rwm}  
 S3/ ok I'd better use the dictionary/ {dic}  
 S4/ 04/.....MT...../ 'chance'/ {rwm}  
 S6/ what does it mean<sup>^</sup>?/ {sdq}  
 S7/ 'obvious'/ {rwm}  
 S8/ 'reaching'/ {rwm}  
 S9/ 'pre' means before/ and 'ceding'/ {ga}  
 S10/ 'feature'/ {rwm}  
 S11/ 'offspring'/ {rwm}

Bottom-up  
interactive

rpwm  
(F: 1)  
dic  
(F: 3)  
cs  
(F: 1)  
rwm  
(F: 8)  
ga  
(F: 1)

**Bottom-up interactive approach used by N12 as his fourth attempt (i.e. fourth stage) to tackle reading problems.**

Fifth Stage

**Text 1**

S5/ does that mean to get<sup>^</sup>?/ {sdq}  
 S7/ 05/ ok I'd better use the dictionary/ {dic}  
 S13/ aha/ our own 'euglena'/ it is strength of heart/ LFV/ {ubk}  
 S15/ 'osmotrophically'/ {rwm}

**Text 2**

S1/ 'survival'/ {rwm}  
 S2/ 'consequence'/ {rwm}  
 S4/ I must look it up in the dictionary/ {dic}  
 S6/ 'value'/ {rwm}  
 S7/ 'obvious' {rwm}  
 S9/ 'preceding generation'/ {rwm}  
 S10/ I reread the sentence to get the meaning of the word/ {rpwm}  
 S11/ 'necessarily' {rwm}

Bottom-up  
interactive

sdq  
(F: 1)  
ubk  
(F: 1)  
rwm  
(F: 7)  
dic  
(F: 2)  
rpwm  
(F: 1)

**Bottom-up interactive approach used by N12 as his fifth attempt (i.e. fifth stage) to tackle reading problems.**



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Sixth Stage

**Text 1**

S13/ I reread the sentence to get the word/ cause it is a pity to skip the sentence and not to understand it/ {rpwm}

S15/ 'osmotrophically'/ {rwm}

**Text 2**

S1/ 'survival'/ {rwm}

S2/ 04/ I should use the dictionary/ {dic}

S4/ 'advantage'/ {rwm}

S7/ 'chance'<sup>RL</sup>/ {in}

S9/ aha/ it must be parents/ {if}

S10/ MT...../ ok I read the rest of the sentence to see whether I get it or not/ {cs}

S11/ 'necessarily'/ {rwm}

Bottom-up  
interactive

rpwm  
(F: 1)  
rwm  
(F: 4)  
dic  
(F: 1)  
in  
(F: 1)  
if  
(F: 1)  
cs  
(F: 1)

**Bottom-up interactive approach used by N12 as his sixth attempt (i.e. sixth stage) to tackle reading problems.**

Seventh Stage

**Text 1**

S15/ 04/ I'd better use the dictionary/ {dic}

**Text 2**

S1/ 'survival'/ {rwm}

S2/ 'ceasing'/ {rwm}

S4/ 'advantage'/WFWT/ {wfw}

S7/ aha it is talking about the chance in S4/ {w}

S11/ 'necessarily'/ {rwm}

Bottom-up  
interactive

dic  
(F: 1)  
rwm  
(F: 3)  
wfw  
(F: 1)  
w  
(F: 1)

**Bottom-up interactive approach used by N12 as his seventh attempt (i.e. seventh stage) to tackle reading problems.**

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*eighth Stage*

**Text 2**

S1/ I must consult the dictionary/ {dic}

S2/ 'ceasing'/ {rwm}

S4/ what can this word be<sup>^</sup>?/ {sdq}

S7/ now I reread the whole sentence to see if I can get it/ {rpwm}

S11/ 'necessarily'/ {rwm}

Bottom-up  
interactive

dic  
(F: 1)  
rwm  
(F: 2)  
sdq  
(F: 1)  
rpwm  
(F: 1)

Bottom-up interactive approach used by N12 as his eighth attempt (i.e. eighth stage) to tackle reading problems.

*Ninth Stage*

**Text 2**

S2/ 'ceasing'/ WFWI/ {wfw}

S4/ MI/ ok I leave this sentence and read the next sentence in the hope that I get it/ {cs}

S7/ O9/ 'reproduce'/ {rwm}

Bottom-up  
interactive

wfw  
(F: 1)  
cs  
(F: 1)  
rwm  
(F: 1)

Bottom-up interactive approach used by N12 as his last attempt (i.e. ninth stage) to tackle reading problems.

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## SI1 Protocol<sup>1</sup>

### First stage

/S4/ 06/ cause it was a long sentence I had to read it again/ {rpls}  
/S6/ 06/ I got model organisms/ that what organisms are included in this category which  
is used as models for the systematic work/ Escherichia coli/ yeast/ maize/ etc/ {p}  
/06/ then in this paragraph/ I highlight those sections I got and specify that what this  
paragraph is all about/ [(highlights S5 and S6)]/ {h}  
/03/ I read the second paragraph and try to relate it to the above paragraph/ {r}  
/S9/ 011/ the word 'and' in S9/ shows the relationship between these two  
different sections/ I had to reread it to see what it is referred to/ {r}  
/S12/ 03/ I highlight S12 up to 'mechanisms' {h}  
/S13/ 012/ I highlight S13 from 'to generalize' up to the end {h}  
the main idea of the paragraph is about the difference between biologists/ those who  
work in the lab/ their approach is selection of models for evolutionary purposes and  
they choose models of 'phylogeny' or something else/ {mic}  
/S14/ I highlight S14 from 'between' to the end/ {h}  
/S16/ I highlight parts of the sentence/ {h}  
/S17/ I highlight the sentence/ and then get back and read these six questions cause  
I think this section is an important part of the article {h}  
/S22/ 011/ I highlight S22 from 'systematics' to 'species'/ {h}  
/S23/ 03/ yes it says that the 'phylogeny' of some species is better understood/ {p}  
/S24/ 08/ I reread this sentence to get the gist/ {rpg}  
S25/ 020/ yes here it says/ em/ on the whole what is going to be summarized/ 'summarize  
some of our own ideas'/ em/ the writers themselves want to express their views concerning  
/ em/ 04/ 'systematic' and other kinds/ em/ 04/ laboratory biologists/ how those who are  
systematists and those who work in the labs on model organisms can assist each other/ {p}  
/S25/ I don't spend time on it cause I see no important points here/ cause I got the theme in the  
first few paragraphs that I read and I understood that what it is going to talk about/ {sts}  
/S26/ 08/ I see some words such as 'wheat'/ I need to read this section again/ {rpwm}  
/S27/ 05/ I highlight this sentence from 'systematics' to the end/ {h}  
/S31/ I highlight parts of S30 and S31/ {h}  
S32/ 03/ few of them are recognized and /now it wants to say how to select these few organism  
from among the others/ {p}  
/S33/ 08/ now it says that what different scientists chose/ {p}  
S34/ 03/ they started by studying organisms/ for example it says what Darwin chose/ and it is  
providing a 'historical background' concerning who chose what/ 013/ then it says about  
'pigeon'/ that why Darwin chose it/ cause there were plenty of them there/ in England/ and/  
em/ there was naturally high 'variation'/ he chose this/ then/ em/ they reached a point that/ 08/ {pwd}  
/S36/ I highlight this sentence/ 'or either crops'/ {h}

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<sup>1</sup> see also SI1's sequence of comprehension strategies on page 293



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First Stage (continued)

S37/ and there are plenty of them/ {pwd}  
it nearly specified in this paragraph that it is talking about selection of organisms to be used as models and has referred to some of them/ and discussed scientists' justification for choosing them/ 08/ these were general ideas/ {mic}  
S39/ then it has referred to an organism which can be relied upon in biology such as 'arabidopsis'/ and then it says why/ 03/ cause they can grow fast in the lab/ {p}  
S40/ or 'xenopus' whose eggs are visible/ 04/ 'breeds often and is easy to maintain'/ {pwd}  
S41/ it has mentioned another organism/ 't4 bacteriophage'/ 03/ 'and its host e coli remain important'/ 09/ 'molecular biology'/ 07/and then it says that they are selected at molecular level/ these are better than those/ eh/ 03/ whose organs have different parts and these are selected due to their fast reproduction and / em/ their ease of transportation/ 020/ {pwd}  
S42/ I highlight S42/ {h}  
S45/ those who work in 'molecular biology' or evolutionary biology/ {pwd}  
S47/ ) I reread the sentence to get its gist/ {rpg}  
S48/ I highlight from 'it is' to the end/ {h}  
S49/ this sentence is the result of the previous one/ {r}  
S50/ I highlight the sentence up to 'life'/ {h}  
S52/ I reread the sentence from 'that' onward to get the gist {rpg}  
S55/ now it has chosen between/ 03/ 'frog'/ 'xenopus laevis'/ {pwd}  
S56/ em/ it talks about an evolutionary topic/ in order to understand that this is a general pattern among amphibians {pwd}  
S57/ it says that 'xenopus'/ 'a generalizable model'/ among amphibians/ 'for all'/ even it is generalizing it to all vertebrates/ 03/ as an evolutionary model organism among amphibians and then it over-generalizes it to other animals/ cause it has a shared characteristic with vertebrates from the evolutionary point of view {p}  
S59/ now it says why it is important/ I highlight S59 {h}  
S62/ now this section is important in this paragraph/ I highlight it {h}  
S63/now it wants to talk about those scientists who work in the lab and those who work on comparative biology/ em {pwd}  
S64/ what characteristics they share with each other from the view point of 'phylogeny' {pwd}  
S65/ here it justifies its reason for the selection/ 02/ for example a comparison among organisms which are different from vertebrates/ 03/ from the view point of evolutionary culture/ they are different {pwd}  
S66/ here it says something about the method of work {pwd}  
S67/ I reread it cause the sentence was important {rpg}  
S68/ here it says that 'phylogeny'/ 03/ what it does is that it 'analyzes pattern' {p}  
S72/ 016/ now it talks about the differences among them {pwd}  
S75/ 03/ I highlight this sentence {h}  
S76/ 06/ I highlight this sentence {h}  
S77/ 09/ I think this section beginning with 'therefore' is very important in regard to the whole article/ therefore I pay more attention to it/ I reread the sentence from the beginning to get the gist {rpg}  
S80/ 05/ from the genetic point of view it has chosen a model/ 03/ and says that how from the evolutionary point of view/ em/ it is talking about genes/ em/ it has chosen/ em/ 'arabidopsis'/ and {p}  
S81/ 020/ it has taken an analytic view and has said something about plants and flowers {pwd}  
S82/ [(reads the sentence in RA mode up to 'angiosperms')] {ra}

First Stage (continued)

S82/ [(reads the sentence in RA mode up to 'angiosperms')] {ra}  
S83/ 04/ then it relates it to 'phylogeny' {pwd}  
S87/ 09/ I highlight this sentence {h}  
S88/ 016/ I highlight the sentence from 'to describe' to the end {h}  
S89/ 07/ it has discussed two more organisms/ 'ascormycete' and  
'schizosaccharomayces' {pwd}  
S92/ 07/ I am highlighting this sentence {h}  
S93/ 09/ here it is discussing the results of the studies/ it says that a new  
door is opened/ 05/ for the synthesis of the genes/ 05/ that all three data  
in one system {p}  
[(reads S95 in RA mode)]/ {ra}

Interactive

rpls  
(F: 1)  
p  
(F: 10)  
h  
(F: 19)  
r  
(F: 3)  
mic  
(F: 2)  
rpwm  
(F: 1)  
rpg  
(F: 5)  
sts  
(F: 1)  
ra  
(F: 3)  
pwd  
(F: 14)

**Interactive approach used by S11 as his first attempt (i.e. first stage) to tackle reading problems. It is noticeable that many of the sentences were automatically processed by the reader and thus were not verbalized.**



Second Stage

S12/ now this sentence/ I reread the sentence beginning with 'potential' up to the end to get the gist/ {rpg}

S16/ 016/ here it has specified the main theme of the article/ that/ em/ it has chosen six papers about/ em/ eight organisms/ it has asked questions about the topics related to these organisms {p}

S17/ the first question is related to 'phylogeny'/ and the their ancestral relations among these/ then it has posed other questions about these eight organisms / em/ and it wants to examine the evolutionary model among them/ these questions are asked here and totally the whole article is based on the answers obtained by the writers working on these models/ {p}

S22/ now there is a word called 'rudimentary' which is unfamiliar to me but I can infer it from the sentence/ I don't know its Persian equivalent/ but I reread the sentence from 'phylogeny' to get its meaning/ {rpwm}

S25/ now it wants to examine the writers' view concerning these two views/ then in this section that I want to read/ it is/ em/ giving introductory information about the paragraph/ {icc}

S31/ 05/ here it says that/ em/ that if we want to do this work we must consider different organisms/ but here in order to understand the problem/ we must know few organisms well/ 05/ in order to reach our target/ 04/ then we generalize this to other things/ {p}

S34/ I highlight S34 too/ {h}

S36/ this too/ their seeds are different/{pwd}

S37/ I highlight 'mice' and 'rat'/ {h}

S52/ [(reprocesses the sentence in RA mode)]/ {ra}

S55/ 06/ as a model organism in what ?/ {sdq}

S59/ [(reads it in RA mode)]/ {ra}

S66/ I rereads S66 to get its gist {rpg}

S72/ [(rereads the sentence in RA mode)]/ {ra}

S82/ organisms which are naturally flower or 'normal'/ it is comparing their genetic similarities/ 06/ then it has discussed 'gymnospermous ancestors' from the evolutionary point of view/ in order to find the origin of angiosperm flowers/ to get information to discuss their ancestors {p}

S83/ I highlight this section cause it is important {h}

S91/ I read up to 'species'/ now I want to reread S91 {rpg}

Interactive

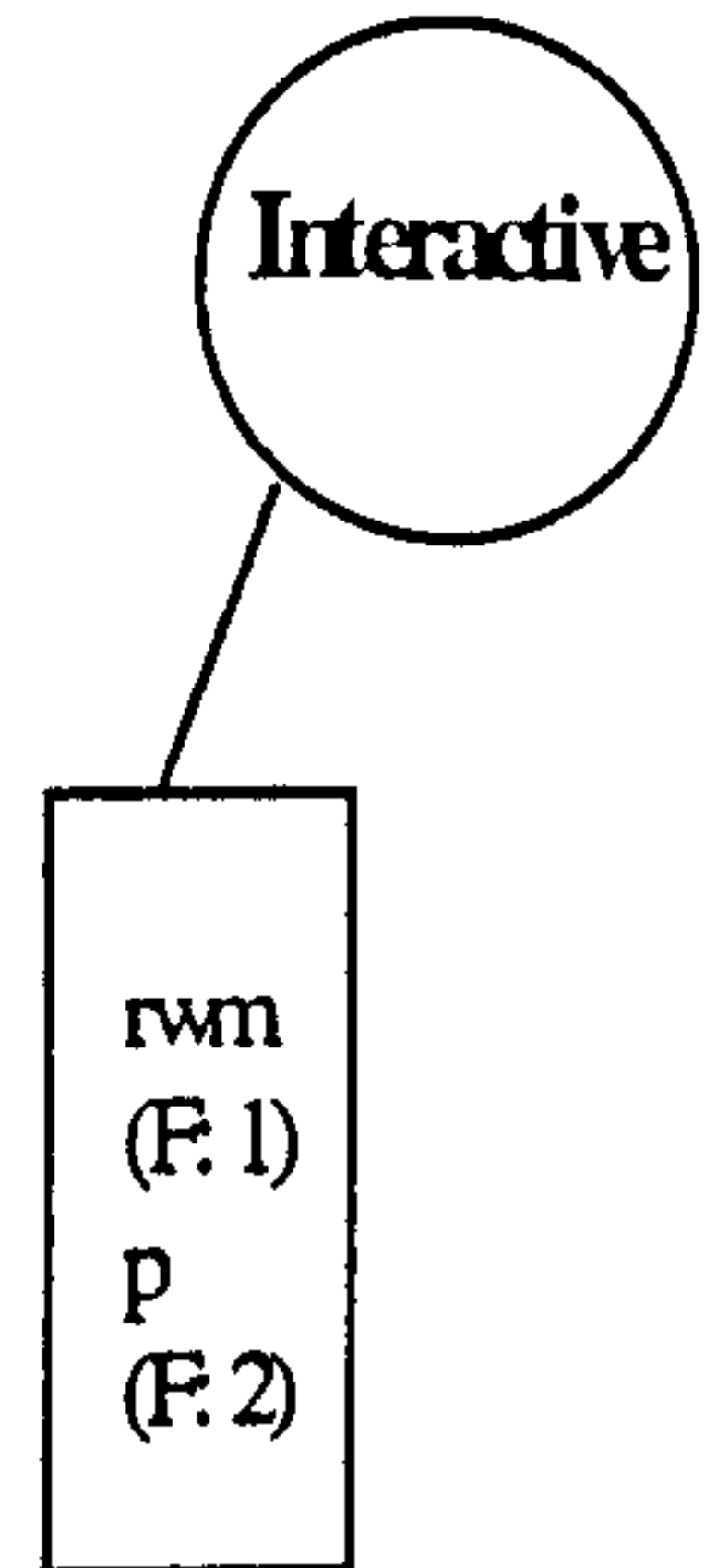
rpg  
(F: 3)  
p  
(F: 4)  
rpwm  
(F: 1)  
icc  
(F: 1)  
h  
(F: 3)  
pwd  
(F: 1)  
ra  
(F: 3)  
sdq  
(F: 1)

Interactive approach used by S11 as his second attempt (i.e. second stage) to tackle reading problems. It is noticeable that many of the sentences were automatically processed by the reader and thus were not verbalized.



Third Stage

S55/ 'vertebrate'/ 013/ 'the neural crest'/ and 'the nature of fertilization' {rwm}  
S66/ 06/ it first asks a question and then tests it {p}  
S91/ there is a need for collaboration between systematists and those who are  
engaged in experimental works/ to discover this {p}



**Interactive approach used by S11 as his third attempt (i.e. third stage) to tackle reading problems. IT is noticeable that many of the sentences were automatically processed by the reader and thus were not verbalized.**

## APPENDIX. C

The following sections are translated transcripts of novice and skilled reader informants' reading protocols of this study accompanied by symbolic figures used in the think aloud protocol analysis.

### Symbolic Figures Used in the Think Aloud Protocol Data

*italic words* = utterances produced originally in English by the subjects

[( )] = utterances produced and information given by the researcher

/02/ = time seconds

↖? = self-directed question

?→ = researcher-directed question

/ = utterance boundary

' ' = utterances read in English as it originally appeared in the text

S4 = sentence number

↗ = rising intonation

↘ = falling intonation

→ = quick reading rate

~~~~ = slow reading rate

==== = emphatic expression

WFWT = word for word translation

RA = reading aloud

RRA = resume reading aloud

RLV = reading in a low voice

LFV = laughing voice

.....MT..... = muttering

/ / = pronunciation boundary

~~~~~ = decoding

RS = reading silently

### Transcription of the think aloud protocol data revealed by NI1

#### Text 1

/S1/ 'Plants characteristically<sup>RLV</sup> synthesize'/ I think this means to construct/ RR/  
'plants'/ 'substances'/ aha/ S2/ 'in green<sup>RLV</sup> plants'/ 'in green plants the energy'/ S3/  
'the plants can use'/ WFWT/ 'this energy'/ WFWT/ 'between'/ aha/ cause they  
'possess'/ have chlorophyll/ aha/ the green pigments/ 'they photosynthesize'/ em/  
synthesis/ light-synthesis/ um/ I think it is not necessary/ as a self-feeding/ I got the  
rest/ there is no point to know every single word/ S5/ 'animals'/ WFWT/ the other  
side/ on the other hand/ aha/ not the other side/ it must contain complex organic



substances by/ 'by eating'/ 02/ OK I read it back from 'must'/ they must obtain /  
aha/ they must obtain complex substances by eating plants or animals / that was  
an easy sentence to me/ S6/ 'the reason'/ the reason is that they 'lack'/  
chlorophyll/ they have chlorophyll/ S7/ 'among these'<sup>7</sup>/ 'among these'<sup>8</sup>/ 02/  
'other-feeders'/ 'or heterotrophs'<sup>RLV</sup>/ I reread it / along these 'feeders'<sup>RLV</sup>/ 'feeders'<sup>RLV</sup>/  
perhaps it is not necessary/ along these or 'heterotrophs'/ aha/ heterotrophs/ 02/  
distinguish<sup>RLV</sup> / recognize between 'solid-feeders'/ I reread the  
sentence from the beginning/ to recognize between 'solid-feeders'/ I don't know  
'phagotrophs' / 'phagotrophs'/ 'liquid-feeders or osmotroph'/ if I want to get its  
meaning I must pay more attention/ perhaps I don't have that much patience/ LFV/  
S8/ 'whereas phagotrophic organisms'/ perhaps the organisms/ 'take in solid and  
often living food'/ and solid foods/ ok/ 'osmotrophic ones absorbs<sup>RA</sup> or suck up  
liquid food'/ S9/ 'this is usually from dead and rotting organisms'/ this is usually/ I  
return back from here/ this is usually from 'dead'/ dead/ aha/ dead organisms and /  
ok/ S10/ 'plants'/ plants and animals often/ 'then'/ then / eh/ 'have  
characteristically'/ I think it means properties/ to have different methods/ aha/ now  
'feed' possibly means to feel/ no/ 'feel' means to feel/ S11/ 'however'/ despite  
this/ um/ 'cannot'/ WFWT/ 'define'/ WFWT/ as autotrophs and animals as  
heterotrophs/ meaning that despite these problems we cannot say that animals are

Appendix C

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heterotrophs and plants are autotrophs/ S12/ 'the reason'/ now it wants to say its reason/ because in plants/ chlorophyll/ 'lack chlorophyll'/ I don't know the meaning of 'lack'/ 'many plants'/ WFWT/ and 'feed heterotrophically' / I read the rest of the sentence to see what it wants to say/ 'and some'/ and a number of animals/ 'possess'/ animals processes/ em/ I couldn't get it/ I reread it cause I think its reason must be important/ its reason is that/ many plants have chlorophyll $\kappa$ ?/ and 'lack'/ I don't know/ perhaps they do not have chlorophyll and 'feed heterotrophically'<sup>RLV</sup> / and / aha, perhaps it is not necessary for them to be heterotrophs<sup>→</sup> / probably it means that/ it most probably means that/ and a number of animals/ 'possess'/ 'pass'/ aha/ they pass/.....MT...../ I think it wants to say that now then some do not have chlorophyll they need to be heterotrophs and then animals must necessarily sometimes be autotrophs/ S13/ 'the problem'/ the problem is that 'illustrated' / 'illustrated $\Delta$ '/ this word is familiar in my mind/ appropriate $\kappa$ ?/ its too familiar but I can't recall it now/ it is perhaps similar to 'illustrament' or 'illustrument'/ aha/ this is because of lack of attention/ LFV/ this is difficult by 'species'/ special/ 'protozoans that are grouped together in the genus Euglena'/aha/ I think I do not read the sentence several times/ that is I do not lay emphasis on each individual word/ I think it says that one substance is 'Euglena' which at the time being I don't know if it is a plant or an animal/ this is because of my previous information/ S14/ 'most species'/ many 'Euglenas'/ have /



'plastid' / 'with chlorophyll inside' / I think they have plastid/ for example chloroplast/ aha/ I think chloroplast for example/ it means that they found chloroplast/ or / oh no/ to become plastid/ em/ 02/ contrary to plants it was something that they had plastid and plants had chloroplast/ and then 'therefore'/ therefore they can 'photosynthesize'/ S15/ in spite of this/ all green species/ 'unable' / I don't know its meaning/ perhaps it means load/ the next word/ they are/ this means that they are green species/ 'synthesize'/ 'at least' <sup>last</sup> one organic substance that they need' / does that mean that they do it for leisure? / LFV/ I didn't get it from the beginning/ no bother I reread it/ in spite of all this/ plants are green/ 'unable' / aha/ they cannot / now I recalled it/ they cannot synthesize/ em/ 'at last'/ 'at least'/ I think it mean the last/ I don't pay more attention to it/ one organic/ main substances/ I always by mistake take this organism as/ 02/ living animals/ but however it is alive/ an alive substance/ my pause here was because of that/ that they need and they must obtain these substances 'osmotrophically'/ 'osmotrophically'/ it hasn't reached my ear/ probably it refers to something in the nature/ I don't know/ ok/ then here the meaning of the sentence is that certain species/ I am just looking at the words right now/ for example green/ are not all able to synthesize/ probably it is the same explanation as the one before/ LFV/ they are therefore/ 'partly'/ I don't know its meaning/ I skip it/ 'partly heterotrophic and autotrophic'/ aha/ perhaps it refers to part of their lives/ aha/

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'part' means part/ portion/ part of their life is autotrophic and the other part is heterotrophic/ S17/ 'the colourless species must obviously be fully heterotrophic'/ I read it again/ 'the colourless' / I don't know why 'colour' is followed by 'less'/ O.K/ but/ 02/ probably the less coloured species/ aha/ it is right/ must 'obvious'/ um/ 'obvious' might possibly mean to observe/ that they are more heterotroph?/ aha/ meaning that/ now I got it/ those which are less coloured/ for example have less chlorophyll/ they are therefore heterotrophs/ .

## Text 2

S1/ when an organism/ an living organism/ 'stops'/ WFWT/ 'reproduction'/ WFWT/ um/ 'its own survival becomes unimportant'/ its survival?/ aha/ when / aha/ it is quite clear that when an organism stops its reproduction its survival becomes certainly unimportant/ S2/ in fact/ along 'larger and complex'/ 02/ greater combination of plants and animals/ I reread it from in fact/ 'among the larger and more complex plants and animals'/ 02/ 'death is'/ 'death is the necessary consequence of ceasing to reproduce when the individual begins to grow old'/ Oh my goodness/ LFV/ I read the next sentence/ S3/ 'it is possible'/ perhaps I can get it in the next sentence/ WFWT/ cause I think most sentences want to say the same thing/ 'it is possible'/ it is possible that all organisms are not similar to each other/ their failure to reproduce is not the same?/ what does that

mean<sup>~~~~~</sup>?/ 'do not die of old age'/ now I read the forward section/ 'it is possible'/  
no/ I read the previous sentence/ LFV/ it is not possible that all organisms are  
similar to this/ aha/ 'it is possible'/ WFWT/ 'it is not possible' means that it is not  
possible/ this is because of lack of attention/ it is possible that all organisms are  
like each other although most 'individuals' / personal<sup>~~~~~</sup>?/ 'old age'/ 'accident'/  
probably they all have the same responsibility/ or/ 03/ diseases/ because they are  
killed by other organisms/ I think there is no relation between the first part of the  
sentence I translated with this last part/ I must have made mistakes/ it is possible  
that all organisms are similar although people<sup>~~~~~</sup>?/ 03/ one of my weaknesses is  
that I read word by word/ and I do believe that I should not do it/ 'do not die'/  
however I can't avoid word by word translation/ I don't know what to do/ 'do not  
die of old age but through accidents'/.....MT...../ S4/ 'how long'/ along/ 'an  
individual survives depends partly on chance and partly on whether it has any  
advantage over the individuals'/ 'how long' means along/ a person by a little  
chance/ aha/ and 'whether it'/ I can't recall it/ it is too familiar to me/ how terrible  
it is/ LFV/ 'any advantage' / 02/ although one is dependent on / now I think if I  
read/ now I didn't understand the upper part of the sentence/ LFV/ 'for example'/  
it is important and probably I can get the previous part of the sentence by reading  
this/ for example when food is not long<sup>~~~~~</sup>?/ 'the better'/ WFWT/ 02/ 'the better  
hunter, or the faster eater, or the larger individual may survive when others  
cannot'/ probably/ 03/ with a quick crack at the beginning/ I don't know/ no I don't

think I can get it cause I didn't read the previous part of it → / I can't really get what it says/ but when food is short/ 'the better hunter or the better eater, or the larger individual may survive when others cannot'/ perhaps something like/ em/ 02/ that one eats more/ that I think it doesn't make sense/ perhaps the one who eats more/ 03/ but no/ it may seem funny to say that the one who eats faster is the one who survives↩?/ LFV/ the one who eats faster and is adopted to the environment is more prone to survive/ something like that/ 'faster eater' and 'may survive' helped me to understand the sentence/ that when others cannot this can survive cause it knows all this/ for example is adopted more in contrast to other individuals/ S6/ 'some individuals'/ 'individual' must have a special meaning that is used frequently here/ I translate it as personally that does not make sense in my sentences/ personal/ some↗/ perhaps it refers to those which are single/ for example some people/ some people/ 'in other words'/ WFWT/ however it is not necessary here/ I don't know what is wrong with my pauses/ if I were reading for myself I would probably read this 'in other words' quicker/ but here I wanted to tell you everything/ I paused / I think it is not necessary to concentrate on it again/ 'some individuals have characteristics'/ some people have survival characteristics/ aha/ 02/ by a quick crack at it my mind returned back to the same example/ I guess I got it/ they have characteristics / 03/ firstly/ those who are better/ it is precisely those who are better in their 'adaptation' in contrast to the rest of the individuals/ therefore my example was correct and I think the above sentences were in fact an

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explanation of the above example/ therefore it was not necessary to read them/ 01/  
now I got it/ S7/ 'obviously'/ ok/ it think it means observable/ if it were me I  
would accept it / 02/ 'the individual'/ people who are more adopted/ chance↗/ aha  
this is important/ better chance for living↗/ 02/ ok/ this section explains more/ I  
reread from here/ 'of living'/ aha/ better <sup>-----></sup>chance for living / 'long enough to  
reproduce'/ I know what 'reproduce' means/ but I prefer to understand its meaning  
in the sentence/ 'of living'/ for living/ enough↖?/. for reproduction/ cause/ in fact/  
I think that the better reproducer was supposed to have better chance for living/  
aha/ for reproducing and not for producing food/ for giving birth/ that is those who  
have better chance then they can better reproduce in the environment/ S8/ 'less  
well-adapted individuals are more likely'/ ok I didn't read it carefully/ LFV/ 'less  
~~~~~  
well' / less well-adapted is better/ .....MT...../ 10/ that in the end/ 'before'/  
WFWT/ 'reaching maturity'/ it don't know its meaning/ I think I can't get it the  
sentence fully no matter how often I read it/ therefore I skip it/ S9/ in / eh/ 02/  
'both'/ sexual and asexual reproductive processes/ this was quite familiar by a  
quick review of the sentence/ 02/ stages/ 'the first stage'/ WFWT/ ' of the new  
generation'/ this is known to me/ 02/ 'is always a part of the preceding'/  
'preceding'↗/ 'prece'/ 03/ 'preceding<sup>RLV</sup> generation'/ reproducing/ no bother/ I  
reread it/ in both sexual and asexual reproductive processes/ the first stages of  
reproducing are always new/ aha/ I think it wants to talk about cell division/ no/ or  
to reproduce an individual similar to itself/ probably the next sentence can help me

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to understand it/ S10/ 'the most important feature'/ it is not necessary to read orally cause I would face short of time/ 'the most'/ the greatest/ the most important 'feature'/ 'of this physical continuity'/ 'continuity'/ this is too familiar/ but/ 03/ 'continuously' 7/ meaning/ 03/ to continue/ perhaps 'continuity'/ 03/ 'continue'/ population/ physical population/ less population fits better in this sentence/ 03/ but no/ it says between reproduction and 'passing on of chromosomes'/ aha/ it wants to talk about the same cell division which I had in my mind/ so it is worth rereading/ RR/ therefore 'the most'/ the most important/ em/ for/ in this for example/ along 'this physical'/ here it refers to the passing on of chromosomes/ S11/ 'individuals'/ people reproduce asexually/ they always have chromosomes/ aha/ here it does not mean to produce/ it says people are/ I read up to the end of the sentence and reread it/ it must be interesting cause it talks about chromosomes/.....MT...../ I review it my mind/ .....MT...../10/ 'identical'/ I don't know its meaning/ .....MT...../ 13/ ok/ I / em/ I don't know many of the words in this sentence but according to my previous knowledge about the chromosomes it says that in individuals who have asexual chromosomes/ first those chromosomes/ or it wants to say that they produce something like their parents/ or is produced by the their parents/ now cause I don't know 'identical'/ perhaps/ but about the sexual reproduction/ 02/ um/ it says that it is certainly produced from chromosomes/ 03/ I admit that my interpretation of the sentence is not accurate/ cause I have something in my mind and I know what sexual and

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asexual reproduction is/ now all such processes are attending in my mind/ but they do not match the explanation here/ S12/ 'in addition'/ individual chromosomes are often/.....MT...../ let me see what this sentence says based on the previous sentence/ .....MT...../026/ I think it wants to say that chromosomes/ 03/ individual/ during meiosis/ probably/ um/ change/ I think it wants to talk about the 'crossing over process'/ meiosis division or 'crossing over'/ cause it says 'exchange'/ probably it wants to talk about 'crossing over' division/ S13/ therefore sexual reproduction 'ensures'/ certainly/ that more individuals/ aha/ the same more/ 04/ more or less difference↯?/ aha/ cause it says the same difference therefore chromosomes must be certainly changed/ cause during meiosis different individuals are produced/ ok I got something from the text/ S14/ 'the importance'/ the most important/ between/ aha/ difference/ no problem/ between the same individuals/ in a short period↯?/ 03/ some are more better than others/ 04/ .....MT...../ RRS/ 05/ the most important/.....MT...../ up to this point it wants to say that/ um/ in one species/ but there is no variation in one species/ aha/ 'ensures'/ aha/ it wants to say something in a short sentence/ that the number of chromosomes/ aha/ the same adaptation/ which caused the production of the new individuals is certainly responsible for more adaptation/ this refers to the same adaptation which was mentioned before during meiosis division/ S15/ 'but the history'/ but the history of the world↯/ history of the world↯/ WFWT/ a funny story/ LFV/ a story of change/ I read it again/ cause I think the last section of the



text is important/ it is in fact the concluding remarks of the text/ but the history of the world is a story 'of change'/ and 'in a changing environment'/ it is interesting/ 'variation may enable a species to survive'/ ok I don't read it cause I know in my mind that it is about survival/ S16/ 'however'/ if the individuals who survive and reproduce new characteristics/ oh no/ to reproduce the same characteristics/ 04/ therefore 'after many generations'/ individuals 'may look'/ WFWT/ different from their 'ancestors' / 'ancestors'/ I don't know its meaning/ I wish I knew it cause it plays an important role in the sentence/ had I had a dictionary I would have looked it up/ S17/ 'evolutionary' / 'evolutionary theory tries to explain how and why this happens'/ 04/ evolutionary theory explains how all this happens/

## Retrospection

[( what is the main information of the text?)]/ well/ it talks about the general biology that we/ have studied/ ok / at first it says about/ 02/ I can't recall/ shall I look at the text?→/ [(ya)]/ 04/ aha/ it says about heterotroph and autotroph organism/ that plants are not merely autotrophs and animals are not heterotrophs/ then the next text talks about adaptation/ then it justifies adaptation by explaining the meiosis division/ [(did previous knowledge help you?)]/ very much/ very much/ [(were the texts interesting?)]/ yes they were/ of course it took me more time to read it/ however if I had read it for myself I would have read it faster/ [(I

noticed that sometimes you muttered during think-aloud)]/ probably I was reading for myself to understand better a difficult sentence)]/ [(thank you very much for your participation in this study)]/

## Transcription of the think aloud data revealed by NI2

### Text 1

[(reads the title in RLV mode)]/ S1/ 'plants characteristically synthesise'/ 04/ 'synthesise complex organic substances from simple inorganic raw materials'/ I reread the sentence to get the meaning of 'raw'/ 06/ 'raw material'/ aha/ now I reread the sentence to see whether I got the meaning of the sentence/ [(reads in RLV mode)]/ 06/ aha I got it/ S2/ [(reads in RA mode)]/ ok I skip it/ S3/ [(reads in RA mode)]/ 'possess'/ 'the plants can use this energy because they possess'/ 03/ I read the rest of the sentence to see if I can get the meaning of the sentence/ 06/ S4/ [(reads in RLV mode)]/ 05/ ok I got it/ S5/ 05/ 'animals'/ 03/ 'on the other hand must obtain'/ 'obtain'/ 04/ I read the rest of the sentence to see whether I understand it or not/ 05/ 'obtain'/ 04/ I can't realize the word/ I reread the sentence from the beginning/ does that mean to get?/ 08/ I got the general meaning of the sentence/ S6/ [(reads in RLV mode)]/ 05/ 'lack'/ I reread from the beginning of the sentence to get the meaning of the word/ 06/ it is a bit difficult/ does that mean not having?/ I think I got it/ S7/ [(reads in RA mode)]/ 'feeders'/ several

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grammatical structures are used here such as 'feed'/ ok I skip it and read the rest of the sentence to see what it says/ [(reads in RS mode)]/ 024/ 'feeders'/ this 'feeders' is my main problem/ 05/ ok I'd better use the dictionary/ [(but in actuality there was no dictionary when the subject was reading the text)]/ S8/ [(reads the sentence in RA mode up to 'absorb')]/ um/ 'absorb'/ 'absorb'/ 03/ I reread from 'osmotrophic ones' to see if can get the meaning of the word/ [(rereads in RA mode)]/ 03/ I need to look it up in the dictionary/ [(no dictionary available)]/ S9/ [(reads the sentence in RA mode up to 'dead')]/ 'dead and rotting'/ 'rotting'/ I can't get the meaning of 'rotting' and I can't guess it from the context either/ I need to look it up in the dictionary/ [(no dictionary available)]/ S10/ 'plants and animals then have characteristically different feeding methods'/ ok I got it/ S11/ [(reads in RA mode)]/ ok it is easy/ S12/ [(reads in RA mode)]/ ok no problem with the sentence/ S13/ 'the problem is well illustrated'/ 'illustrated'/ 'the problem is well illustrated'/ 'illustrated'/.....MT...../ I read the rest of the sentence to see if I can get it/ [(reads the rest of the sentence in RLV mode)]/ aha/ our own 'euglena'/ it is strength of heart/ LFV/ I reread the sentence to get the word/ cause it is a pity to skip the sentence and not to understand it/ 07/ ok I got it now/ S14/ [(reads in RA mode up to 'inside')]/ what does 'i e' stand for?/ 03/ 'for example'/ something like this/ after all this explanation is not necessary and worth spending time on it/ I skip it/ S15/ [(reads the sentence in RLV mode)]/ 'least'?/ 'least'/ I read the sentence from the beginning to see the meaning of the word/ 04/



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I'd better use the dictionary/ [(no dictionary available)]/ 018/ 'osmotrophically'/  
'osmotrophically'/ 04/ I'd better use the dictionary/ [(no dictionary available)]/  
S16/ [(reads the sentence in RLV mode)]/ ok I got it / S17/ [(reads the sentence in  
RLV mode)]/ ok I reread it to get the gist/ 06/ on the whole it is a good text/

## Text 2

/S1/ [(reads the sentence in RLV mode)]/ I reread the sentence to get the gist)]/ 05/  
'its survival'/ 03/ ok I read it again to get the gist/ 05/ 'unimportant'/ 'survival'/  
'survival'/ I don't know it/ I must consult the dictionary/ [(no dictionary  
available)]/ 019/ S2/ [(reads in RLV mode)]/ 'death is the necessary consequence

RLV

'7/ 'consequence'/ 'consequence'/ this word is too familiar to me but I can't  
recall it now/ 'consequence'/ 'consequence'/ 04/ I should use the dictionary/ 09/  
'ceasing'/ 'ceasing'/ WFWT/ S3/ [(reads the sentence in RA mode up to  
'individuals'/ 'individuals'/ I should reread the sentence to get the meaning of the  
word/ 07/.....MT...../ 'of old age'/ ok I'd better use the dictionary/ [(no dictionary

available)]/ S4/ [(reads in RA mode)]/ 06/ 'chance' <sup>RLV</sup>7/ I have to reread the

sentence to get the word/ 09/ 'depends' <sup>RLV</sup>7/ 04/.....MT...../ 'chance'/ I must look  
it up in the dictionary/ [(no dictionary available)]/ 017/ 'advantage'/  
'advantage'/WFWT/ what can this word be?/ 04/.....MT...../ ok I leave this  
sentence and read the next sentence in the hope that I get it/ S5/ [(reads the

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sentence in WFWT manner)]/ aha/ perhaps it refers to the prey/ I have to look it in the dictionary for its exact meaning/ [(no dictionary available)]/ 019/ ok I got it/ S6/ [(reads in RA mode)]/.....MT..../ what does it mean<sup>RLV</sup>?/ 'in other words' <sup>RLV</sup> ↗/ what does it mean<sup>RLV</sup>?/ [(reads from 'have characteristics' to to the end of the sentence in RA mode/ 'value'/ S7/ 'obviously' <sup>RLV</sup> ↗/ 'obviously'/ 'obviously'/ 'obvious'/ 'obvious'/ [(reads the rest of the sentence up to 'chance')]/ 'chance' <sup>RLV</sup> ↗/ aha it is talking about the chance in S4/ now I reread the whole sentence to see if I can get it/ 09/ 'reproduce'/.....MT...../ S8/ [(reads the sentence in RA manner)]/ 'maturity'/ 03/ 'maturity'/ 04/ 'reaching'/ 'reaching'/ ok I can't get it/ S9/ [(reads the sentence and parses it in WFWT manner)]/ 'preceding' <sup>RLV</sup> ↗/ 'preceding'/ WFWT/ 'pre' means before/ and 'ceding'/ 'preceding generation' / aha/ it must be parents/ S10/ [(reads the sentence in RA mode up to 'features')]/ 'feature' <sup>RA</sup> ↗/ 'feature'/ 'feature' <sup>RA</sup> ↗ / 'feature'/ I reread the sentence to get the meaning of the word/ 09/.....MT...../ ok I read the rest of the sentence to see whether I get it or not/ S11/ [(reads the sentence up to 'parents' in RA mode)]/ 'identical'/ 'but sexually produced'/ 03/ 'offspring'/ 'offspring'/ 'offspring'/ 'necessarily'/ 'necessarily'/ 'necessarily'/ aha/ S12/ [(reads the sentence up to 'altered' in RA mode)]/ 'alter'/ I think 'alter' means to change/ ok/ S13/ [(reads the sentence in RA mode)]/ ok I got it/ S14/ [(reads the sentence up to 'term' in RA mode)]/ what does 'term' mean here<sup>RLV</sup>?/ a period I suppose/ 'short term'/ 05/ ok I got it/ S15/

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[(reads the sentence in RA mode)]/ 'survive'/ aha/ 'survive'/ ok / S16/ 'however'/ WFWT/ [(reads from 'if' to the end of the sentence in RA mode)]/ can 'ancestor' mean supporter?/ probably it is like its previous ancestors/ ok/ S17/ 'evolutionary'/ 'evolution'/ 'evolutionary theory'/ WFWT/ ok it was an easy sentence/

## Retrospection

[(what were the main ideas of the texts?)]/ it was about reproduction/ at first it explained the difference between plants and animals/ their different characteristics/ then it said about reproduction/ different kinds of sexual and asexual reproduction/ in regard to asexual reproduction the chromosomes are not changed to a great extent/ every characteristic in parents is transferred to their children/ generally they do not alter/ 05/ their properties are not altered but in sexual reproduction due to a new arrangement the characteristics may be different from those of the parents after few generations and it is explaining all this in evolutionary studies/ [(do you keep the text better in mind when you pronounce it?)]/ well when I pronounce something I can keep it in my mind better/ [(somewhere in S1 of T1 you said that you got the meaning of the word 'raw'/ what does that mean?)]/em/ 04/ I think it means something which is not clean/ [(you almost skipped S2 in T1/ why?)]/ 08/ it was too obvious to me/ that was the main reason I skipped it/ [(what do you think about the meaning of the word



'possess' in S3 of T1?)]/ let me see/ 08/ I guess it means to have/ [(in S13 of T1 you were supposed to tell what you got from 'illustrated'/ but apparently you ignored it or forgot to report it/ what happened?)]/ 09/ well/ honestly I didn't get it/ that was why I didn't report it/ [(in S1 of T2 you said that you are rereading the sentence to get the gist of the sentence/ could you please tell me what you got from it?)]/ 028/ I think it says that/ em/ reproduction is related to one's own survival/ something like that/ [(thank you very much for your participation in this interview)]/

### Transcription of the think aloud data revealed by N13

#### Text 1

[(reads the first paragraph in RA mode)]/ 029/ ok I got the first paragraph/ S5/ 010/ I returned to 'organic substances' to see what it wants to get by eating animals and other plants/ S6/ 08/ this phrase 'they lack chlorophyll'/ this 'lack' is unfamiliar to me and I have to look it up in the dictionary/ 018/ S7/ 030/ this word 'feeders' is not known to me/ 'feeders'/ I leave this word cause it is talking about fluid and gas/ 07/ I use the dictionary/ 016/ I pause on 'whereas'/ I don't know its pronunciation/ is 'whereas' separate?→/ [(no)]/ S8/ 030/ this 'osmotrophic'/ 03/ 'osmotrophic'/ 02/ is not known to me/ that is my problem/ S9/ 013/ I got it/ now I read the next paragraph/ S10/ 010/ I got it/ S11/ 012/ I don't know why 'define' is

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underlined/ 03/ 'define'/ 02/ 'define'/ 03/ I still don't know what it means/ I reread the sentence from the beginning to see if I can get it or not/ 05/ whenever I encounter a word or a phrase in a sentence which remains unknown to me then I can't continue the sentence/ or the text/ cause whenever I face a new unknown word I tell to myself that I would understand the word if I knew the word/ therefore I can't continue the text/03/ and I prefer to leave the words and read other sentences to see if I can get the words/ 02/ ok I read the first sentence of the next paragraph/ I got the whole sentence with a quick look/ 03/ that's why/ for example when I want to read this/ for example 'however'/ um/ no/ I picked up the sentence in one look/ then as soon as I saw 'lack' and 'feed'/ 02/ I can't understanding the sentence because of the two words no matter whether I know the rest of the sentence/ I can't get anything from the sentence/ I put it aside and try to understand it right up there/ S13/ 08/ this word/ em/ 'well illustrated'/ 07/ the pronunciation of this word 'protozoans'/03/ I don't know what it could mean/ 'protozoans'/ 03/ we have protozoans but I doubt if it is the same / 05/ S14/ 05/ here again 'possess'/ 'possess'/ 08/ I don't know what it is/ I am furious/ I prefer to look it up in the dictionary/ 09/ [(no report of S15 to S 17)]/

### Text 2

/S1/ 09/ ok for example I don't know this word/ I had a meaning in my mind/ but this meaning doesn't fit in the sentence but I am sure I have got the right meaning/

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for example 'reproduction'/'reproducing'/?/ um/ this word for example/ 03/  
means reproduction/ then when/ not that/ then when I read the sentence word by  
word I can only then understand it and make another meaning/ for example it can  
also mean complete/ [(the subject does not report her thought processes of S2)]/  
028/ S3/ 029/ here again the word 'accident'/' I don't know its meaning/ however  
cause it has referred to 'disease' it may mean that/ it says that an animal or plant  
death could be referred back to soil and that shows the continuation of life/ of  
course a proportion of these animals are killed by disease or other animals/ [(the  
subject does not report her thought processes of S4 to S5)]/ S9/ 05/ I don't know  
this 'preceding'/' you don't help me either/ LFV/ S10/ 027/ this 'physical

continuity '/ I can't find 'continuity'/' 017/ 'generation'/' I had a little doubt  
concerning this word but now I think it is generation/ S11/ 028/ 'identical'/' I keep  
this word and read the rest of the sentence/ again here I pause on 'offspring'/' here  
it is comparing sexual with asexual reproduction/ um/ it wants to say that asexual  
reproduction does not depend on parental relationships/ 07/ 'combination'/' I also  
don't know 'combination '/ 'combination'/' 'combination'/' S12/ 021/ for example/  
'altered'/' 'altered'/' it reminds me of 'alteral'/' or 'alternator'/' during 'meiosis'/'  
S13/ 024/ for example I don't know what 'ensures' means but I could get the  
meaning of the sentence/ [(reads S13 and S14)]/ 035/ I think this last paragraph/  
um/ doesn't have any relationship to the text/ I think it is giving advice/ I don't  
know why I have this feeling/ 014/ 'survive'/' it is too complex/ it is too complex/ I



do my best and return back later to get its meaning/ S16/ 034/ I don't know what 'ancestor' means/ 025/ I know the meaning of the sentence but it is not easy enough/ I have something in my mind but it is not comprehensible yet / S17/ 025/ whenever I write the meaning of a sentence/ 03/ and leave blank the meaning of the words I don't know / then/ 03/ I edit it/ I reread it/ I also omit some of the words/ and try to translate the text and give it to my instructor/

### Retrospection

[(in S13 of T1 you spent time on 'well illustrated' but did not skip the sentence while in the case of the word 'feed' in S12 you decided to put it away and read the next sentence/ why?)]/ 010/ cause I had problems with 'feed' and 'lack' up there too/ now that I return to them I have the same feeling/ I concentrated a lot on these two words but it didn't have any effect/ [(in your report of S1 of Text 2 you said that you read a sentence word by word and that after this word for word reading you pose another meaning to it/ could you please elaborate it more?)]/ my approach is that I translate a sentence word by word and after doing this I return to the beginning of the sentence and assemble the pieces/ I first distinguish the words I don't know/ 03/ I can't keep the meaning of all words in my mind/ 03/ it is not like Farsi [(refers to her first language)] where I can understand the text at the same time that I read/ in the case of English I first read words and then try to relate them together/ [(do you do it with every sentence?)]/ oh yes with every sentence/

then whenever I face an unknown word I try to find it right at the same time/ there shouldn't be any unknown word in my second reading/ you know what I mean/ [(what if you didn't have a dictionary?)]/ em/ I can't put that word aside and ask somebody its meaning/ [(do you usually skip a word you don't know when neither the dictionary nor an external help is available?)]/ no/ I skip the whole sentence/ [(you mean you cannot fill the gap even with the help of other words that are familiar to you in the sentence)]/ no I can't/ I can't assemble the words in the sentence/ [(why didn't you think-aloud the first paragraph of T1?)]/ 08/ I have no idea/ probably I did it cause I thought I was reading the text as if I was not expected to report my thoughts/ [(in S7 of T1 it is implied from what you said that 'feeders' was not important but incidentally you decided to look it up in the dictionary/ why did you change your mind?)]/ 09/ well/ I thought that it was an important word/ that was why I decided to look it up in the dictionary/ [(thank you for your participation in this study)]/ thank you/

### **Transcription of the think aloud data revealed by N14**

#### **Text 1**

/S1/ 05/ I read the sentence and although there were two to three words that I don't understand I got the main gist/ S2/ 09/ S3/ 08/ I must also tell you that based on my previous knowledge concerning biology I can understand the text quickly/ 030/

S7/ I read the sentence and I think I should reread the sentence to get the gist/ 018/  
although I didn't get two of the words I /em/ continue the paragraph to see what  
happens/ S8/ 024/ I didn't understand the sentence and I have to reread the  
sentence/ 023/ one or two words/ um/ on the whole I got the meaning of the  
paragraph/ it is all about the animals but I couldn't get two or three words/ 03/ and  
I couldn't understand the meaning of the last sentence/ 03/ ok on the whole since  
there is no dictionary available I go on to read the next paragraph/ S10/ 017/ ok/  
S11/ 028/ I read a bit quicker to monitor the sentence in my mind to see if I can get  
the meaning of the sentence/ 018/ although there is no dictionary I could get the  
general message of the text by resorting to my previous knowledge/ S12/ 039/ ok I  
read S15/ 017/ I reread the sentence to get the gist of the sentence/ 08/ S16/ 07/ it  
was a short sentence/ 03/ although I don't know the meaning of the word 'partly' I  
understand what it is saying/ S17/ 013/ ok this word '<sup>/abvi3ali/</sup>obviously' / I couldn't get  
the word/ um/ ok/ um/ 03/ on the whole I understand that it wants to say  
something about the colourless species/ that these species must be totally  
heterotrophic/ something like this/

## Text 2

/S1/ 05/ I must tell you something/ I said that if there was a dictionary I could feel  
more comfortable/ when I don't know the meaning of a word I usually check it  
with a dictionary/ I read quicker if I have access to dictionary/ um/ I mean my

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weakness is that I have a limited range of vocabulary in my mind and am dependent on the dictionary/ LFV/ ok I am telling whatever is in my mind/ cause I wanted to read a bit quicker then I lost my concentration/ you know what I mean/ now I want to read a bit quicker/ if I want to read for myself I don't read the sentence with the speed I am reading this text now/ but now I have this feeling that I have to read the text quickly/ you know what I mean/ I want to make full use of the time/ S2/ 016/ ok I couldn't get this word/ 'individual'/ 017/ I reread the sentence from the beginning/ 'in fact'/ WFWT/ 'among the larger'/ WFWT/ 'and more complex plants'/ WFWT/ I don't know 'individual/ 017/ S3/ [(reads the sentence up to 'like this' in RA mode)]/ it says that organisms should be like this/ 'although'/ WFWT/ 'individuals'/ WFWT/ 'do not die of old age'/ 04/ 'but through accidents'/ had I known the words that are repeated here I could have read quicker/ 'individual'/ 010/ when I don't understand two or three words I feel that I am losing my motivation to continue/ I feel as if I am losing concentration/ but on the whole I am familiar with the words/ um/ and sometimes I enjoy reading without interruption/ but as soon as I see that I can understand it gives me strength/ that's why I am motivated to read/ but if I want to render its meaning I must tell you that I'd better put it away/ you know what I mean/ now I read the next paragraph/ [(reads S4 up to 'whether' in RLV mode)]/ 011/ I couldn't get the sentence/ S5/ [(reads the sentence in RA mode up to 'hunter')]/ I didn't get it/ I read it again to get its gist/ 06/ it says that the one that eats faster/ um/ can get its

food quicker/ 04/ something like this/ S6/ 'some individuals'/ 'some individuals'/  
'in other words'/ could you please tell me what this 'individual' means?→/  
[(individual)]/ aha some individuals/ 'have characteristics'/ WFWT/ um/ 04/ 'have  
a survival'/ I don't know its meaning/ can I ask you to tell me its meaning?→/  
[(survival)]/ what about 'value'?→/ [(value)]/ value/ 04/ S7/ 'obviously'/  
'obviously'/ [(reads the sentence up to 'higher' in RA mode)]/ now that you told  
me what 'adapted' means/ befitting came into my mind/ I reread the sentence  
cause I think I can get the sentence/ 03/ I got the sentence although I couldn't get  
'obviously'/ S8/ 'less well adapted'/ 03/ 'individuals are more likely to meet death  
before reaching'/ ok now why 'less' is used at the beginning of the sentence↵?/  
here I couldn't get the word 'maturity'/ I reread the sentence to see if I can guess  
what it means/ 08/ aha/ [(reads the sentence up to 'new' in RA mode)]/ ok I got  
this section/ 'the first stage'/ ok I know what it wants to say/ 04/ S10/ 'the most  
important feature'/ 08/ ok/ 02/ although it was a short sentence I didn't know two  
words/ 03/ I reread the sentence to get the meaning of the two words/ [(reads the  
sentence to the end in RLV mode)]/ 08/ aha/ 02/ I can guess something/ it talks  
about sexual and asexual reproduction cause it refers back to chromosomes/ S11/  
[(reads the sentence up to 'identical' in RLV mode)]/ aha/ I got it/ based on my  
previous knowledge I got what it wants to say about the reproduction/ I also didn't  
know about this word 'identical'/ S12/ [(reads the sentence to the end in RA  
mode)]/ 04/ I reread the sentence to get its gist / [(reads in WFWT manner)]/ aha/



04/ I couldn't get one word but based on what I have in mind I can tell you what it wants to say/ but I must confess that if it was not for my background knowledge it was too difficult to say what it wants to say/ 03/ in fact I referred to my previous knowledge to check my understanding/ S13/ [(reads the sentence in RA mode)]/ 02/ I think I need to reread the sentence to get its gist/.....MT.../ 013/ um/ with the exception of one word I know how to interpret the sentence/ but here it says 'all more or less'/ I don't really know what it is/ S14/ [(reads the sentence up to 'means' in RA mode)]/ I reread the sentence to get the meaning of one word/ 05/ between individuals of the same species/ 03/ ok I skip it/ 04/ ok since I am supposed to tell you everything now I am thinking whether what I am reading is the same thing that you want to get/ I mean/ the same problem I told you earlier that/ 04/ I sometimes omit parts of the text that I think are trivial/ you know/ we are taught to ignore them/ that was why I was thinking whether to disregard this or not/ 08/ S15/ [(reads the sentence to the end in RA mode)]/.....MT.../ ok I nearly got it/ 03/ S16/ [(reads the sentence up to 'their' in RA mode)]/ ok this sentence was a bit long/ in the meantime I was thinking about the time/ I reread the sentence to get its gist/.....MT...../ ok I still do not know what 'ancestor' means/ 03/ ok I got something/ 03/ when I read a text such as this/ one of my methods is that I first read a text to make it familiar to my eyes/ then I put it away/ but when I want to translate a text/ for example/ em/ usually I read it as it occurs in my mind/ I underline words that I don't know/ 03/ then I enter it into a sheet/ then I look it up



in the dictionary/ then I start reading it/ as it occurs in my mind/ no matter wrong or right/ I jot it down in a piece of paper/ then I read it to see if it is meaningful/ whenever it sounds odd I get back to the original text to see if it could have another meaning or not/ ok/ S17/ 'evolutionary'/ ok I don't know the meaning of the word/ 'evolutionary theory'/ WFWT/ 'tries to explain how and why this happens'/ aha/ I got it / it wants to say that why this happens and so forth/

### Retrospection

[(obviously you didn't report your understanding of many of the sentences in both texts/ so I would be obliged to ask you some more questions about the texts/ first what was the main idea of each text?)]/ um/ 08/ on the whole it talked about the differences between plants and animals/ 07/ it described plants/ and /03/ heterotrophs and autotrophs/ then it emphasized their survival and the rest/ [(in S14 of T2 you said that you were thinking whether to disregard something in the sentence/ what was that?)]/ um/ 09/ ok I think that was the phrase 'in the short term'/ it seemed to me unimportant/ [(you did not report your thought processes when reading some sentences for example S2, S4 and S5 of T1/ what was the reason?)]/ let me have a look at them/ 029/ I think I thought that I understood them/ that was the main cause of not reporting them/ [(what would you say if I ask you to tell me your understanding of the main points in the first two paragraphs of T1?)]/ well I need to read them/ can I read them/ [(sure)]/ 048/ well I think the first

paragraph explains/ em/ how plants get their energy/ from sunlight/ and the reason is that they are to photosynthesize/ the second paragraph deals with animals/ it says that since animals do not have this ability of photosynthesizing then they have to eat other animals/ and then it talks about two different groups of animals/ heterotrophs and phagotrophs/ [(could you please tell me your understanding of S11 of T1?)]/ em/ 013/ 'individuals produced asexually'/ it talks about two types of reproduction/ I mean asexual and sexual/ [(getting back to S8 of T2 you showed unfamiliarity with 'maturity'/ you then said that you needed to reread the sentence to get its meaning/ and you confirmed it/ what is your understanding of the word?)]/ 08/ I think it refers to an age level/ doesn't it?/ [(oh ya)]/ [(was the text interesting to you?)]/ em/ you become happy when you see that you understand an English text cause you have previous background knowledge/ [(thanks a lot for your participation in this interview)]/ my pleasure/

### **Transcription of the think aloud data revealed by N15**

#### **Text 1**

/S1/010/ I read the sentence a bit fast/ cause I read it fast I reread it in order to concentrate/ [(reread S1 in RS mode)]/ 013/ I reread the sentence to see what the sentence was all about/ [(reread S1 in RS mode)]/ 08/ ok I got it/ S2/ 014/ I read the sentence but I need to reread it/ the problem is that I read a bit fast/ if

I read slowly I can understand it better / [(rereads the sentence in RS mode)]/  
05/ ok I got it/ S3/ 014/ 'possess'/ I stopped here/ 02/ I don't know its  
meaning/ probably its similarity with the word 'pass' pulls one to the idea that  
it is probably derived from 'pass'/ however I doubt it/ however the physical  
similarity of the word pulls me towards 'pass'/ cause it is similar to 'pass'/  
now I want to see what happens in my understanding if I omit this word/  
[(rereads the sentence in RS mode)]/ 08/ I guess 'possess' means to have/ here  
it means to have/ cause I read the sentence from the beginning I got a general  
view of the sentence and it was here that I thought 'possess' means to have/  
and I think that I am right/ S4/ 014/ now my problem perhaps is that I can't  
concentrate on the sentence for the first time/ I reread it/ [(rereads the sentence  
in RS mode)]/ 06/ 'autotrophic'/ ok it is known to me/ 'autotrophic'/ 04/ ok I  
admit that it was a bit difficult for the first time/ but now I can recall what it  
means/ S5/ 06/ ok here the meaning is clear but I don't really know why 'on  
the other hand' is not used at the beginning of the sentence/ first it has used  
'animals' and then 'on the other hand'/ if it was used at the beginning of the  
sentence it would be easier for me to understand it/ [(rereads the sentence in  
RS mode)]/ 010/ I can't concentrate/ I reread the sentence/ [(rereads the  
sentence in RS mode)]/ 013/ I couldn't get the gist of the sentence/ and I don't  
know why/ I read the sentence three times but I failed/ I reread the sentence/  
[(rereads the sentence in RS mode)]/ 07/ probably I don't have the required

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concentration/ there was a grammatical structure/ 'must obtain complex organic substance'/ here 'organic substance'/ 04/ I don't know whether to consider it a word/ a combination of words to which 'complex' is added/ but here 'by eating plants or other animals'/ aha/ this 'eating plants' was for the first time/ em/ something questionable/ then I thought a bit more and I recalled that there is a series of plants that are carnivorous/ probably it means that/ doesn't it?→/ [(if I were you I would pay more attention to the sentence)]/ 'on the other hand must obtain complex organic substances by eating plants or other animals'/ by eating plants/ aha/ ok I got it/ my first interpretation that I had in my mind is wrong/ whereas here it means by eating and using plants/ but it came to my mind that probably it refers to carnivorous plants/ now I don't really know what the reason was/ but by rereading the sentence I recognized that it was not true/ S6/ 09/ here I stopped on this word 'that'/ this 'that'/ it says that 'the reason for this is that'/ here 'this is that'/ this make a serious case/ it wants to say that because of this that/ the reason for this is that/ aha/ perhaps it means the word that/ it is a relative word/ 04/ 'lack'/ 'lack'/ in the first place it reminded me of the word lock/ to lock something/ aha/ that is 'lock'/ it was very similar to it/ I think it means/ 04/ it mustn't be to lose/ now I reread the sentence to see if I can find 'lack' in its general position/ [(rereads the sentence in RS mode)]/ 06/ I think it means to have/ to include/ 04/ by and large it says that the reason for that is that they have chlorophyl/ 02/ S7/ 07/ 'feeder' comes from 'food' meaning to

give food/ doesn't it?→/ 'feeder' must be present participle/ those who receive food/ 'other feeders'/ other food users/ 016/ 'osmotroph'/ 'osmotroph' is a bit unfamiliar/ on the other hand the sentence is a bit difficult meaning that it had different parts and therefore a bit longer than usual/ therefore I lost the general overview of the sentence/ I need to reread the sentence/ 020/ now I got 'osmotroph'/ cause 'or' is used before 'liquid-feeder'/ when I reread the sentence from the beginning I found by the help of 'or' that it must mean organisms that use water/ 'osmotroph'/ S8/ 011/ here 'absorb' considering my previous familiarity with word 'adsorb'/ I think it has a similar meaning to that/ they have a close similarity to each other/ 'adsorb' and 'absorb'/ but it is questionable to consider them to have one meaning/ but basically it must mean to absorb/ but I haven't heard 'suck up'/ I think it is a new expression/ 'suck up'/ I reread the sentence to get the general meaning of the sentence/ 'take'/ 'take' that I have already familiarity with is something strange here/ 03/ 'take' means to lift something/ now I want to see whether it has the same meaning/ 05/ or to take part/ 'take in'/ probably it is a new expression/ but I don't have any idea in my mind about what it really means/ perhaps it refers to use something or to take something/ 09/ here again 'suck up' may mean 'absorb'/ cause we have 'or' here/ 03/probably that they have the same meaning/ I take them as one word having a similar meaning/ S9/ 06/ here again 'rot' is questionable to me/ what does 'rot' mean?/ it reminds me of the word root/ but it mustn't be that/ cause here it has got 'ing'/ root doesn't



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receive 'ing'/ it basically wants to express a verb which has got 'ing'/ of course sometimes nouns are changed into verbs/ aren't they?→/ probably it may mean to spread root/ I don't really know/ I reread it probably I can get it/ 08/ but whatever it is 'rotting organisms' must be equivalent with 'dead'/ 02/ there must be a similarity cause both are brought in here/ perhaps it wants to complete the meaning of 'dead'/ 03/ cause it can't be a synonym/ whatever it is there is an emphasis here/ dead organisms/ probably/ any way/ death/ something like that/ I got the main idea of the paragraph/ 03/ generally/ 04/ I feel I need to read the whole paragraph again/ bearing in mind that I tried to translate the text word by word my concentration was on words and it caused me to lose the whole meaning of the paragraph/ to get the main idea of the text I need to read the paragraph again/ 024/ the main idea of the paragraph was about methods of feeding/ S10/ 07/ here it has used 'then'/ between two commas/ it is questionable that why it is used here/ whether it has wanted to emphasize something/ whether to say that we pay more attention to this word/ it is ambiguous/ it is strange to see why he has done it/ what was the reason and why 'then' is not used at the beginning of the sentence/ 07/ I got the sentence and I read the next sentence/ S11/ 04/ ok here the use of 'as' attracts my attention that what it is/ I read a bit quickly and I reread the sentence cause 'as' has attracted my attention/ 07/ aha we can translate it as as/ therefore here the use of 'as' does not compare something with something else/ cause I thought that 'as as' is used for comparison/ and I found that the comparison



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function does not fit in the meaning of the sentence/ S12/ 08/ here again the word 'lack'/ 02/ like before it is ambiguous/ I have to read the sentence/ 011/ I need to reread the sentence/ 04/ I think it means not having/ I got it by the help of 'heterotrophically'/ that plants that do not have chlorophyl feed this way/ [(rereads the sentence in RS mode)]/ 04/ I had already encountered 'possess' and I couldn't reach any solution/ I reread the sentence to see whether I can get the meaning of the sentence / 013/ 'possess' means to have/ I got it by the help of 'and feed autotrophically'/ I got it with regard to the general meaning of the sentence/ S13/ 04/ here the expression 'well-illustrated' is used which I guess means to encourage/ am I right?→/ 'illustrate' means to draw/ it says well drawn/ I reread the sentence to see the interpretation I had in my mind is correct or not/ 018/ I reread the sentence/ 06/ I got a general view of the sentence/ that it is talking about an organism called 'Euglena'/ I think it is a sea organism/ but now I am thinking about aemibs/ 03/ protozoans are usually called mono-cells/ and not plants/ therefore/ 07/ the main reason why I can't concentrate is that I can't understand the 'problem'/ does it refer to the previous sentences↖?/ most probably it does/ I refer back to two or three sentences before to see if there is any emphasis on the 'problem'/ 018/ this 'reason' creates problems to me/ the question is whether some animals can have chlorophyl/ can they have chlorophyl↖?/ 06/ the same question probably the same problem refers to chlorophyl and that some animals are 'autotrophs'/ 'and possess it'/ and this refers back to chlorophyl/ now this problem

in my mind that animals can have chlorophyl is perhaps in the writer's mind too/ I mean it is unnatural to see animals possess chlorophyl/ I got the problem by returning to the beginning of the paragraph/ I read the sentence from the 'problem'/ 039/ therefore 'illustrate' can mean to explain/ cause it wants to 'illustrate' the 'problem'/ I got it that the problem is that some organisms such as 'euglena' have chlorophyl while they are mono-cells and they are not supposed to have it / S14/ 06/ here 'plastid' presents a question/ 'plastid'/ aha/ I got it/ it means plastid/ cause 'with chlorophyl'/ so it must mean plastid/ [(read the sentence in RLV mode from 'chlorophyl inside')]/ 05/ I paid attention to this paragraph/ 'i e' means equal/ or it means meaning that/ I don't know what it stands for but I know what it means/ S15/ 015/ I have lost my concentration/ I reread it/ 04/ the reason I don't understand is that I read the sentence word for word and therefore I don't know the main idea of the sentence/ the reason I get back is to get the main idea of the text/ cause I emphasized the words and not the general meaning of the text/ I initially try to understand the word one by one and then to get the main idea of the text/ I pause on 'however'/ 04/ again I refer back to 'however'/ 014/ it is a long sentence and I lost the idea in the sentence/ basically I have to reread the sentence/ 018/ I got something but still the problem is there/ I am not satisfied/ the problem is the length of the sentence/ it is difficult to understand it/ [(rereads the sentence in RS mode)]/ 020/ here 'osmotrophically'/ I got something/ it says all kinds of plants/ here 'osmotrophically' is used as an adverb/ probably it wants to put



emphasis on the verb and says that these organisms or these plants that are not able to synthesize this organic substance must feed osmotrophically/ S16/ 04/ here 'partly'/ 'part' means a portion/ to take part/ but is 'partly' an adverb?/ I prefer to read up to the end of the sentence/ 06/ ok here it is not an adverb/ and it means section/ but I don't know why an 'ly' is used with it/ but considering the use of 'and' which connotes similarity I guess that it must mean section/ but again I don't know why an 'ly' is used with it/ [(rereads the sentence in RS mode)]/ 03/ ok/ S17/ 05/ 'obviously' is a bit unfamiliar to me/ perhaps it means 'obvious'/ obvious/ [(rereads the sentence in RS mode)]/ 08/ I reread the sentence to get its main idea / I emphasized the words and I can't get the main idea quickly/ 05/ I got it/

## Text 2

/S1/ 018/ 'survival' is not known to me and I don't know its meaning/ 05/ I reread the sentence from the beginning/ 011/ again I paused on 'survival'/ 07/ I reread the sentence / 020/ I am sorry I couldn't get it/ S2/ 017/ I paused on 'death'/ 02/ ok/ I reread the sentence to get what it means/ 07/ I don't really know what 'death' means/ 016/ 'consequence'/ I don't know its meaning/ 06/ /*keising*/ 'ceasing'/ I don't know what it is/ 04/ I reread the sentence / 029/ I got the sentence to some degree/ S3/ 030/ now cause I can't pronounce this word correctly I can't get its meaning/ [(you mean 'individual'?)]/ oh yes/ I reread



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the sentence/ 030/ I got the sentence to some degree/ I'd better reread the sentence/ 020/ I pause on 'individual'/ 07/ I read the rest of the sentence/ 09/ S4/ 030/ I pause on 'advantage'/ I guess it comes from 'advance'/ 05/ I guess the sentence is going to ask a question/ I am a bit confused by it/ I reread the sentence/ 030/ ok/ I am stuck with some words that I don't know/ and I didn't get the sentence/ I reread the sentence/ 03/ whatever it is/ 'individual' is an adverb/ 029/ I reread the sentence/ 022/ I can't get it/ S5/ 013/ I don't know what 'hunter' means/ ok it is used within two commas/ I continue the sentence/ 013/ I'd better reread the sentence/ 030/ I got the sentence/ S6/ 016/ I pause on 'individual'/ 012/ I reread the sentence/ 03/ 'some individuals'/ 030/ I'd better reread the sentence/ 026/ ok I got it/ S7/ 'obviously'/ 05/ I don't know what it means/ 017/ what is this word?→/ [(higher)]/ 030/ ok I got the sentence/ S8/ 010/ I pause on 'well adapted'/ I guess 'less'/ 024/ 'maturity'/ I can guess what it means/ adulthood/ 029/ .....MT...../ S9/ 024/ I don't know what 'preceding' means/ I reread the sentence/ 021/ I'd better reread the sentence/ 08/ no/ I can't get what 'preceding' means/ S10/ 017/ I don't know what 'feature' means/ 020/ I reread the sentence/ 021/ I got the sentence though I couldn't get what 'feature' means/ S11/ 029/ I pause on 'identical'/ 04/ I don't know what it means/ 017/ I don't know what 'offspring' is/ 017/ I couldn't get anything from the sentence/ I reread the sentence/ 030/ I got the sentence though I didn't know some of its words such as 'offspring' 'individual' and 'identical'/ S12/ 021/ 'individual'/ I

guess it might mean single/ 05/ I don't know what 'altered' is/ I pause on it/ 030/ I reread the sentence/ 026/ I don't really know what it is/ S13/ 015/ I don't know what 'ensures' is/ 015/ I got the gist of the sentence/ S14/ 021/ I got something from the sentence/ but I'd better reread the sentence/ 020/ ok I got it/ [(he misses S15)]/ S16/ 014/ although I didn't know what 'ancestor' is I feel I need to reread the sentence/ 020/ I couldn't get the sentence/ S17/ 029/ ok I got it/

### **Retrospection**

[(what are the main ideas of the texts?)]/ It has firstly compared plants and animals/ their differences/ em/ and some exceptions such as 'euglena'/ cause some of them/ em/ they can't produce organic substances/ they are classified as protozoans that are different from both plants and animals/ and then it continues/ 03/ it talks about the necessity of reproduction/ 03/ um/ and that an organism/ em/ 04/ may not reach its maturity during its life/ I mean it may face natural events/ enemy/ hunter/ and doesn't reach the reproduction stage/ but when it reaches reproduction/ em/ it can reproduce organisms similar to itself/ [(you seemed to be less talkative while verbalizing the second text/ what was the reason?)]/ just a bit tired/ [(what did you get from S2 of T2?)]/ um/ 08/ I think it is talking about age and reproduction that when one stops reproduction it becomes useless/ [(and what you got from S3 of T2?)]/ 09/ it says that some organisms are killed by accidents or other organisms/ [(well so far so good/ I

would be pleased if you tell me the main of idea of paragraph 2 of T2)]/ um/ can I have a look at the paragraph/ [(sure)]/ 047/ I think its all about/ em/ animals life/ I mean 'individual's life/ 07/ that those who eat faster are more successful than other animals/ and/ em/ they can live longer/ [(much obliged for your participation in this study)]/ it was an interesting session for me too/

### Transcription of the think aloud data revealed by N16

#### Text 1

/S1/ 012/ I need to reread the sentence to get its gist/ cause I read it a bit quickly and couldn't get it/ 012/ although each word is comprehensible to me I don't have a general view of the sentence and I feel I need to translate it in my mind/ 02/ I am analyzing the sentence to get a general view/ I reread / 06/ ok I got the sentence by a quick review/ [(reads S2 in RS mode)]/ 06/ quite understandable/ I got it in my first trial/ [(reads S3 in RS mode)]/ 08/ every piece of the sentence is known to me/ 05/ oh yes all words and concepts are known to me/ [(reads S4 in RS mode)]/ 06/ this 'self feeding' is unfamiliar to me/ 03/ to understand it I need to reread the whole sentence/ 07/ ok I got the word/ 05/ oh yes quite understandable/ now I read the next paragraph/ [(reads S5 in RS mode)]/ 05/ the first part of the sentence was ok but not the second part/ to get the second part I need to return to the beginning of the sentence



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cause it was obscure/ 05/ ok it is crystal-clear/ [(reads S6 in RS mode)]/ 07/ ya quite clear/ [(reads S7 in RS mode)]/ 08/ 'heterotrophic' is not known to me/ and I can't grasp it/ I need to reread the sentence/ 012/ still unclear/ I reread the sentence/ 011/ I can't get it and I can't guess it either/ I reread it for the fourth time/ cause/ I think I should understand the sentence cause its words are clear/ 017/ I almost got it/ but I can't still guess what 'heterotroph' is/ 05/ I couldn't get the sentence/ I haven't even heard of 'osmotroph'/ ya because of these two words the sentence appears problematic/ [(reads S8 in RS mode)]/ 013/ this sentence was a bit difficult/ I reread the sentence to get a general view of it/ 013/ it is still difficult for me/ I read the rest of the sentence probably I can get the first part/ [(reads S9 in RS mode)]/ 013/ ya I got it/ the paragraph's main idea deals with a comparison between plants and animals/ plants are shown to be independent in terms of producing food but animals are said to be plant consumers/ 02/ animals use already made foods while plants get their food from raw materials/ [(reads S10 in RS mode)]/ 05/ ok I got it/ [(reads S11 in RS mode)]/ 014/ I understand the sentence but I think there is a contradiction between these two sentences/ I reread the two sentences together/ 018/ I think my problem here is that I don't have a clear idea about the exact meaning of 'however'/ I reread from 'however'/ 07/ despite my rereading I can't grasp the meaning of the sentences and I can't solve the contradiction/ I think my problem is this word 'however'/ [(reads S12 in RS

mode)]/ 014/ no problem at all/ but I reread it to make sure/ it was a simple sentence/ 010/ ok I could solve the ambiguity of the first part of the sentence/ [(reads S13 in RS mode)]/ 012/ I didn't see any difficult word but I couldn't grasp a general view of the sentence/ I reread the sentence/ 025/ I reread it once more/ 022/ I could get the whole sentence but this word 'euglena'/ I can't really get it/ ok I skip it and read the next sentence to see if I can get it/ [(reads S14 in RS mode)]/ 011/ no problem and I could nearly get what 'euglena' means/ ok/ the phrase within the parenthesis gives a better definition/ [(reads S15 in RS mode)]/ 013/ not clear/ I reread from 'however' to get a general view/ 013/ I could almost understand the sentence/ 09/ 'osmotrophically' doesn't make sense/ because of this I need to reread the whole sentence/ 013/ ya/ I got it/ [(reads S16 in RS mode)]/ 012/ I got the sentence/ [(reads S17 in RS mode)]/ 013/ I read the sentence however the paragraph itself was a bit heavy for me and I think I'd better reread from 'most species' to get the main idea of the paragraph/ 027/ ok I got it but it is not as clear as the previous paragraphs/

## **Text 2**

[(reads S1 in RS mode)]/ 013/ I paused on 'reproducing'/ 05/ I reread the sentence to get the word/ 07/ ok it is clear/ I reread the whole sentence to get its gist/ 010/ the words are familiar to me but I couldn't get a general view/ I

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reread the sentence/ 013/ I reread the sentence from 'its own'/ 011/ [(reads S2 in RS mode)]/ 017/ the word 'ceasing' is not clear/ I mean I have a problem with the sentence/ I reread the sentence from the beginning to get the word meaning/ 014/ I can't still grasp 'ceasing'/ I can't understand the end section of the sentence/ I reread from 'consequence'/ 010/ I couldn't get the last part/ I skip it and continue the sentence to see if I can get it/ 09/ I pause on 'individual'/ 012/ words are individually known to me but I don't have a general view of the sentence/ I reread the sentence from 'when'/ 014/ ok almost clear/ [(reads S3 in RS mode)]/ 09/ I reread the sentence to get the gist/ 015/ I reread once more/ 017/ I don't have a general view of the sentence and I am stuck with 'do not die'/ [(reads S4 in RS mode)]/ 04/ I reread the sentence to get a general view of the sentence/ 010/ ok I got it/ it was a long sentence but now I could grasp it/[(reads S5 in RS mode)]/ 08/ I don't know what 'hunter' is/ I reread the sentence from the beginning/ 019/ I couldn't grasp 'hunter'/ but I don't have any problem in understanding the sentence/ I reread the sentence from the beginning/ 017/ I couldn't get much from the sentence but I have got a general meaning/ [(reads S6 in RS mode)]/ 07/ 'characteristics' is familiar to me/ however I'd better reread the sentence cause I feel I have some difficulties with the sentence/ 010/ ok I got it/ [(reads S7 in RS mode)]/ 012/ it is quite clear/ [(reads S8 in RS mode)]/ 06/ I concentrate on 'more likely' and reread the sentence/ 08/ ya/ got it/ but I have rather difficulty with



the word 'maturity'/ I read the sentence from the beginning/ 012/ ok now clear/ [(reads S9 in RS mode)]/ 014/ the words are all familiar but I'd better reread the sentence from the beginning/ 014/ I don't have any idea about 'preceding'/ I reread the sentence/ 019/ I still don't know what it means/ [(reads S10 in RS mode)]/ 09/ the word 'continuity' is not clear for me/ I reread the sentence/ 05/ ok got it/ I read the rest of the sentence/ 012/ all the words are known to me but I don't have a general view of the sentence/ I reread from 'the most'/ 010/ ok I think I got the sentence/ [(reads S11 in RS mode)]/ 05/ I reread the sentence from 'that are'/ 013/ it is not clear/ I need to reread the sentence from the beginning to get the gist of the sentence/ 023/ I read up to 'parents' and now I continue reading from 'but'/ 012/ every individual word is known to me/ but the reason as to why I have a problem with the sentence may be the length of the sentence/ I think if I read a bit faster I can get what 'individual' is/ 025/ ok/ [(reads S12 in RS mode)]/ 03/ I paused on 'individual chromosomes'/ I reread the sentence/ 09/ I can't pronounce this word 'meiosis'/ [(/miosis/)] ok it becomes clear/ I reread from the beginning to get a general view/ 017/ I paused on 'due to'/ all the words are familiar but I don't know why I don't have a general view of the sentence/ I reread the sentence from the beginning/ 016/ I nearly got it/ [(reads S13 in RS mode)]/ 05/ I paused on 'ensures'/ I don't know its meaning/ I reread the sentence from the beginning/ 015/ I reread the sentence up to the end but still have problems

with the sentence/ 012/ I nearly got a general view and translated 'ensures' as to cause/ [(reads S14 in RS mode)]/ 019/ the words are quite known but to get a general view of the sentence I reread it from the beginning/ 018/ I nearly got it/ [(reads S15 in RS mode)]/ 07/ I paused on 'history of world' and reread the sentence from 'but'/ 017/ I paused on 'may enable'/ it is not clear thus I decide to reread the sentence from 'but'/ 013/ ok/ [(reads S16 in RS mode)]/ 012/ I reread from 'however' to get the sentence/ 018/ I don't have any problems with words but I failed to grasp the whole sentence/ 011/ I think the problem comes up after 'then after' which is not clear to me/ [(reads S17 in RS mode)]/ 03/ I paused on 'tries' and I intend to reread the sentence to get it/ 04/ aha I got it/ I reread the sentence to get its gist/ 09/ ya/

### **Retrospection**

[(obviously in many of the sentences you read you indicated that you got them/ can I ask you some questions about them?)]/ ya/ [(looking back to S4 of T1 you initially had a problem with 'self-feeding'/ can you tell me what it means?)]/ em/ 09/ I think it might refer to autotrophic process because of the word 'or'/ it refers to an organism which provides for itself/ [(in S5 of T1 you said that you had a problem with the second part of the sentence/ what was wrong with it?)]/ 019/ I guess the problem was this 'on the other hand'/ you know/ I could not initially relate the first part to the second part/ but after a



second reading everything became clear to me/ [(moving back to S11 of T1 you somewhere in you verbal report said that you found a contradiction in the sentence/ what caused you to have such a feeling?)]/ em/ let me see the sentence/ 07/ ok I thought that 'cannot' had to be/ em/ positive rather than negative/ I should say that we can define bearing in mind that the point is clear/ that's why I couldn't get why he said 'cannot'/ [(you said that the last paragraph of T1 was not as clear as the other paragraphs/ what was wrong with the paragraph?)]/ 05/ I think the reason was 'species' and another word 'euglena'/ I didn't have any background knowledge about them while previous paragraphs were quite familiar to me and I didn't have any problems with words/ [(back to paragraph 1 of T2 you said that you didn't have a general view of the paragraph/ what was wrong with the paragraph?)]/ 09/ I think the length of the sentence was the main cause/ cause I had to keep all the words in my mind/ the words didn't pose any problem to me/ [(just a sentence after the above paragraph you said that the sentence was long but you nearly got the sentence/ was it a grammatical problem?)]/ 08/ at least here I didn't have problems with grammar/ [(referring back to the end of S8 of T1 you said that 'maturity' was not known to you but after a backtracking move you said that you got it/ could you please tell me what 'maturity' might mean)]/ 09/ I think it means reaching adolescence/ [(in S12 of T2 you paused on 'due to'/ why did you do that?)]/ 04/ although it means to cause I could not understand the



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sentence from the grammatical point of view/ I simply couldn't get it/ [(at the end of the same sentence you confirmed your understanding but your tone was weak suggesting that you still had problems/ didn't you?)]/ let me see/ 05/ I got the sentence that it wants to say that chromosomes are divided during meiosis due to a change of material between them/ [(thank you very much for your participation in this interview)]/

### Transcription of the think aloud protocol data revealed by NI7

#### Text 1

/S1/ 'plants characteristically<sup>~~~~~</sup> synthesize complex organic substances from simple inorganic raw materials'/ character must be an adjective/ an adjective for plants/ 03/ now I read the next sentence in the hope to understand the previous sentence/ RRA/ WFWT/ S3/ 'the plants can use this energy because they'/ WFWT/ 'they possess the green pigment chlorophyll'/ WFWT/ 'possess'<sup>RLV</sup>/ 'they possess the green pigment chlorophyll'/ they use/ it must be something like that/ they use green pigments/ S4/ 'autotroph'/ 03/ 'photosynthesis or light-synthesis'/ WFWT/ 'light' means light and 'synthesis' means to construct/ it is a 'self-feeding'/ 'feeder' is feather/ 'self'/ .....MT...../ or 'autotroph'/ or autotroph process/ OK 'autotroph'/ what is the opposite of autotroph<sup>↖</sup>?/ autotroph or/ 04/ S5/ 'animals on the other hand/ WFWT/ 'must obtain'/ WFWT/ 'complex organic

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substances'/ WFWT/ 'by eating plants or other animals'/ WFWT/ S6/ 'the reason for this is that they lack chlorophyll'/ the reason is that they 'lack'↯?/ 'lack'/ 'lack'/ to lose/ they lose chlorophyll↯?/ 'lack'/ they use chlorophyll/ S7/ 'among these other-feeders or'/ 03/ 'heterotrophs'/ aha/ this is heterotroph then/ 'we distinguish between solid'/ 03/ 'feeders'/ em/ 'other-feeders'/ 'feeders'/ it may be users or heterotrophs/ it says that either we distinguish between solid-feeders/ 'solid'/ 'solid'/ 'solid-feeders'/ or/03/ 'phagotrophs'↯?/ 'phagotrophs'↯?/ 'and liquid-feeders'/ aha/ liquid users/ 'liquid-feed' /or 'osmotrophs'↯?/ 'osmotrophs'↯?/ this probably comes from the osmosis pressure/ S8/ 'whereas phagotrophic organisms'/ WFWT/ 'take in'/ participate/ 'solid and often living'/ they often live/ food/ 'osmotrophic ones absorb or suck up liquid food'/ aha/ it says that those that are osmotrophic.....MT...../ S9/ RRA/ WFWT/ S10/ RRA/ WFWT/ S11/ RRA/ WFWT/ S12/ 'and some animals possess'/ 'possess'↯?/ 'possess'↯?/ it may mean to consume/ S13/ 'the problem is well-illustrated' / I reread it/ 04/ 'well-illustrated' is difficult/ 'ill'/ 'by various species'/ WFWT/ 'of protozoan' / 'protozoans' / 'that are grouped together in the genus Euglena' / I read it again/ 05/ it is difficult/ it is difficult/ what is that↯?/ what is that then↯?/ various species/ protozoans/ protozoans/ they are in the genus Euglena/ in the genus Euglena↯?/ in the genus Euglena↯?/ I read it again/ it is difficult/ 04/ 'illustrated' / I couldn't get it/ S14/ 'most species'/ other species/ 'of Euglena'/ WFWT/ 'possess'/ again use/ 'plastid

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with'/ WFWT/ 'chlorophyll inside'/ WFWT/ 'inside'/ WFWT/ 'i.e., chloroplast'/  
'and therefore'/ WFWT/ 'they can'/ WFWT/ 'photosynthesize'/ WFWT/ S15/  
'however'/ WFWT/ all the green species are unable'/ WFWT/ 'to synthesize'/  
WFWT/ 'at least one organic substance that they need'/ WFWT/ aha/ 'and they  
must obtain'/WFWT/ 'these substances'/ WFWT/ 'osmotrophically'/ aha/  
'osmotrophically'/ aha/ osmosis/ S16/ 'they are therefore partly'/ they are / em/  
therefore they are partly↗/ 'osmotrophic'/ partly osmotrophic/ 'and partly  
heterotrophic'/ WFWT/ S17/ 'the colourless'↗/ 'the colourless'↘/ species/  
WFWT/ often/ 'must'/ 'obviously' / 'obviously'/ 'be fully heterotrophic'/ OK  
given the thing I know about the colourless species/ what must they do↗?/  
'obviously be fully heterotrophic'/ WFWT/

## Text 2

/S1/ 'when an organism stops'/ em/ 'reproducing'/ 'reproducing'/ when an  
organism/ an alive creature/ stops/ 'reproduce'/ the result/ producing again/ its  
production as it were/ its reproduction/'its own survival'/ that survives/ 'becomes'/  
um/ 'unimportant' / 'unimportant'↗/ 'unimportant'↘/ aha/ 'unimportant'/ LFV/  
trivial/ 'its own'/ it survives/ what happened↗?/ when an organism stops its  
reproduction it survives but becomes trivial/ S2/ 'in fact'/ WFWT/ 'among the  
larger and more complex plants'/WFWT/ 'animals'/ WFWT/ 'death is'/ the dead/



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it is death/ 'the necessary consequence' / 'consequence' / 'of ceasing<sup>RLV</sup>' / what happened $\aleph$ ? / of what to reproduce $\aleph$ ? / death is/ death is the necessary of what $\aleph$ ? / 'to reproduce' / I read it again to see what it said/ it says that in fact among/ considering that alive organisms are important/ 'among' / among the larger and more complex creatures death is the end/ death is necessary/ 'consequence' / 'consequence' / I don't know its meaning/ 'of ceasing' / of what to reproduce $\aleph$ ? / death is/ death is necessary/ what necessary $\aleph$ ? / to reproduce/ when 'the individual */indiadiual/* begins to grow old' / when the */indiadiual/* 'individual' / 'divide' / separation/ 'individual' / when the separation begins for growth  $\rightarrow$  / S3/ 'it is possible that all organisms' / WFWT/ um/ that all organisms are alike/ 'although most' / although often/ 'individual' / 'do not die' / are all divided $\aleph$ ? / they cannot die/ 'of old' / they cannot/ 'old' / 'of old' / WFWT/ aged/ 03/ 'age but' / at old age $\aleph$ ? / 'but' / 'but through accidents' / WFWT/ 'or' / and 'disease' / 'disease' $\nearrow$  / 'disease' $\searrow$  / I wonder if it has reached my ear/ I am familiar with most of the words which are familiar to my ears/ sickness/ 'disease' / 'disease' / 'or because' / 'or */bikeiz/* because' / 'because' $\nearrow$  / 'because' / 'because they are killed by other organisms' / I skip this */bikeiz/* 'because' / S4/ 'how long an individual survives depends partly on chance' / it says how long an 'individual' / in a division form/ it probably means fission  $\rightarrow$  / on what does an individual survival depend $\aleph$ ? / it depends on 'chance' / 'partly on chance' / how

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Appendix C

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much causality is involved in this matter 04/ LFV/ 'how long'/ how long one survives/ this verb has got an 's'/ 'individuals'/ fission/ processes/ 'survives' is the verb cause it has got an 's' and 'individual' is a noun/ division survives and it depends on chance/ how long this division survives depends on chance/ and 'partly'/ the other part of it/ 'whether'/ 'whether'/ on the other hand/ 'on whether' 01/ 'it has any'/ 'advantage'/ 'advantage'/ 'advantage'/ um/.....MT...../ 'over other individuals'/ .....MT...../ S5/ 'for example'/ WFWT/ 'when food is short'/WFWT/ 'the better hunter'/ the best/ 02/ 'hunter' <sup>RLV</sup> 01/ 'hunter' <sup>RLV</sup> 01/ 'or the fast'/ aha/ meaning faster/ 'faster eater'/ the one who eats faster/ 02/ or the best hunter/ and the faster eater/ 02/ 'or the larger individual'/ and the biggest divider/ 'may survive'/ WFWT/ when others cannot/ what does it want to say 04/ aha/ the largest and the fastest hunter/ 03/ S6/ 'some individuals'/ some dividers/ 'in other words'/ WFWT/ 'have characteristics' / em/ have/ 02/ 'characteristics that have a survival'/ that have remained something and we say that they have better adaptation to the environment/ ya/ it says about adaptation / those that can survive  
-----> / S7/ 'obviously' / 'the individuals'/ some dividers/ 'which are better adapted to their environment'/ WFWT/ 'have a higher chance'/ have a higher chance in life/ they live longer/ 'enough to reproduce'/ aha/ WFWT/ S8/ 'less well-adapted'/ em/ 04/ 'individuals are more likely to meet death before  
~~~~~  
reaching' / 'reach'/ aha/ 'reaching'/ 'maturity'/.....MT...../ and it says less

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adaptation/ less adaptation/ those that are less adapted are those that are more similar to/ 'meet' / 'meet' / meet / 04/ before they reach 'maturity' / this must be reproduction/ 04/ similar to what? / those that are less adapted are similar to/ are similar to dead meat/ before they reach 'maturity' / 'maturity' / aha/ adulthood/ S9/ 'in both sexual and asexual reproductive processes' / WFWT/ 'the first stage' / WFWT/ 'of the new generation' / 'generation' / 'generation' / 'generation' / 'preceding' / 'the new generation is always a part of the preceding generation' / 04/ it is a new 'generation' which is part of 'preceding generation' / 'generation' / 04/ generation? / initial generation/ S10/ 'the most important' / WFWT/ feather/ 'feature' / 'feature' / 'of this physical continuity between generations is the passing on of chromosomes' / 03/ I read the next sentence/ the most important 'feature' / of this physical continuity/ is 'continuity' between generations/ 'passing' / 'passing' / to pass/ to pass chromosomes/ these chromosomes are an important issue/ S11/ 'individuals produced' / they produce/ 03/ asexually/ they always have chromosomes that are *identikal* / 'identical' / 'identical' / 'identical' / 'identical' / 04/ 'identical to those of their parents/ 04/ to their parents/ what to their parents? / to their parents/ it says those that have asexual reproduction / 02/ they have chromosomes that they inherit from their parents/ 'but sexually' / but in sexual reproduction/ 'produced offspring necessarily possess a new combination of chromosomes' / but in sexual reproduction/ what is involved in



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it?/ 'a new combination' / 'combination' / 'combination' / 'combination of chromosomes' / what new aspect of chromosomes?/ aha/ a new chromosome  
 -----> must be produced in sexual reproduction/ new characteristics must be produced by chromosomes/ S12/ 'in addition' / WFWT/ 'individual chromosomes' / chromosomes are often producers/ 03/ 'altered during' / 'altered' / 02/ 'altered' / what often happens during meiosis?/ 'due to an exchange' / 04/ moreover the chromosomes of those that are sexually produced are divided into new chromosomes during meiosis/ 02/ 'to an exchange' / till a change / 'change' / to alter / 'exchange' / to change / 02/ no it should mean that / 'exchange' / to change material / it happens between chromosomes / S13/ therefore / 'sexual reproduction' / WFWT/ ensures / ensures / 'ensures that' / 'ensures that the members of a species are all more or less different' / in sexual reproduction / um / I think certainly / that the members of a species are more or less / aha / they are produced more or less differently / the new members are more or less different from their parents / from their mother cell / S14 / 'the importance of variation' / difference / 'variation' / varieties / 'between individuals' / between dividers / 'of the same species' / of identical species / 'means' / meaning that / 'in the short term' / em / 02 / in a short time / are better adapted than others / S15 / 'but the history' / WFWT / is a story / 'story' / a story of exchange and in a / 02 / 'chāngīng' / in an environment change / the environment varieties may / 02 / to change the environment / to select the

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environment/ 'variation'/ varieties may 'enable'/ they can/ they possibly can/ they may change/ the unable might become able and the able might become unable/ S16/ 'however'/ although/ 'if the individuals'/ although/ if dividers survive and reproduce then they have a 'new characteristics'/ new attributes/ that/ 'then'/ then after 'many generation'/ WFWT/ 'the individuals'/ the dividers may 'look very'/ may seem much different from 'their <sup>~~~~~</sup>ancestors' / 'ancestors' ↗/ OK/ those living in the earlier times probably/ new characteristics are produced which are different from the earlier ones/ S17/ 'evolutionary'/ 'evolutionary' ↗/ 'evolutionary' ↘/ 'evolutionary <sup>~~~~~</sup>theory' / theory/ 'tries'/ attempts/ 'to explain'/ to give information about how/ 'and why'/ that why all this happens/

## Retrospection

[(what are the main ideas of the texts?)]/ it talked about the sexual and asexual reproduction/ their differences/ em/ the ways that genetic characteristics are transferred from one generation to another generation/ the first text said things about the variation among animals and plants/ em/ which section ↖?/ aha / photosynthesis/ it explained photosynthesis/ organisms that from the view point of their feeding are autotroph and heterotroph/ and that the plants are the vital producers and that others are dependent on them/ [(you obviously raised questions to yourself when you were thinking-aloud/ why did you do that?)]/ well/ I think it helps me to concentrate on the difficult section and allows me to recall it/ to find a

solution/ [(how were the texts?)]/ honestly I think the texts were suitable but/  
LFV/ but as for me/ 02/ I usually need more time to read and understand better/  
this is a main difference between me and my classmates/ [(were the texts  
interesting to you?)]/ oh yes/ cause they were known to me/ [(what if they were  
not familiar to you?)]/ well I wouldn't have motivation to read/ and I wouldn't get  
much from the texts/ [(thank you very much for participating in this interview)]/

### **Transcription of the think aloud data revealed by N18**

#### **Text 1**

/ S1/ 06/ again from 'plant'/ 013/ the meaning is quite clear/ S2/ 06/ S3 / 05/ the  
meaning of 'process' is a bit ambiguous/ 06/ I return to the beginning of the  
sentence/ 014/ although 'process' is still not known to me I got the sentence/ S4/  
014/ I paused on 'autotrophic'/ cause I didn't know its correct pronunciation/  
however its meaning is quite clear/ S5/ 07/ I had a problem with this sentence but I  
could resolve the problem by the help of the last few words/ I mean 'must obtain  
complex organic substances'/ this was a bit difficult for me/ then by eating other  
plants it became clear that it refers to obtaining organic substances/ S6/ 02/ I  
reread the sentence/ 04/ the meaning is not clear/ I reread it/ 06/ now it is clear/ I  
mean I lost my attention cause I was still thinking about the previous sentence/  
S7/03/ this 'other-feeders' is incomprehensible/ it is not familiar to me/ 07/ again I



have a problem with this 'feeders'/013/ in this sentence 'feeders' is not clear but the rest of the sentence is known to me and biological terms are used/ I reread the sentence from 'among' to get what 'feeders' means/ 06/ I am focusing on 'other feeders' to get it/ 022/ again on 'feeders'/ 02/ there are relationships between 'heterotroph' or 'other-feeders' and 'phagotrophs' or 'solid-feeders'/ 'heterotroph' and 'phagotroph' refer to different methods of eating which exist among different animals/ being eaters/ 'heterotrophs' as opposed to 'autotroph' cannot produce something itself and are dependent on other animals/ 06/ I reread from the beginning of the sentence I mean from 'among'/ 06/ probably regarding 'heterotroph'/ 03/ we can point out that it may refer to other-feeders/ a creature that uses other animals/ S8/ here/ 010/ here the meaning is a bit/ 03/ the meaning of this 'and often living food'/ I had difficulty in relating this to the previous sentences/ I reread it from the beginning of the sentence/ 016/ I continue the sentence though 'and often living food' is not clear to me/ 012/ due to a problem in my understanding I reread the sentence/ 015/ the problem is not solved however I go forward/ S9/ 010/ here a word caught my eyes and that is 'rotting'/ 02/ cause its meaning/ 02/ I don't know its Persian equivalent/ 02/ I get back to the beginning of the sentence/ 010/ I can somehow understand the sentence that/ 03/ 'phagotrophs' and 'osmotrophs' often feed from/ 03/ dead organisms and/ 02/ I still cannot get what 'rotting' means/ S10/ 011/ in this sentence too/ 02/ all the words are clear except 'feeding' which its Persian equivalent is not known to me/

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*Appendix C*

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03/ I don't know/ 04/ S11/ 014/ all the words seem to be familiar to me however to get a better understanding/ 02/ I get back to 'however'/ 010/ now it is clear/ S12/ 031/ there are two words in this sentence that due to the length and/ 02/ lack of good command of English/ the technical words are easy however I had a problem in pronouncing 'heterotrophically' and 'autotrophically' due to their length/ it took me a bit time to pronounce it/ I had also problems with 'feed' and 'possess'/ 02/ 'possess' and 'feed'/ these are a little unrelated/ I mean I don't know them/ 03/ now if/ I wish I understood them when I read them/ but now if I read them again I must keep their meanings in mind/ I have to repeat them/ S13/ 017/ I pause on 'grouped'/ 02/ but no/ it is familiar to me/ 04/ I can understand this word by the help of the word 'uglena'/ 02/ by the help of my background knowledge I can understand the sentence/ S14/ 04/ I got what 'possess' means/ it most probably means to include/ 011/ it was 'inside' I mean 'chlorophyll inside'/ by a slight pause I could get it/ S15/ 029/ due to the length of the sentence/ 02/ I could hold the meaning up to a point then I lost control of the sentence/ I get back to the beginning of the sentence/ 029/ in this sentence 'osmotrophically'/ 02/ it is not clear what it wants to say but/ 03/ however I could grasp the meaning up to the organic substance but 'these substances osmotrophically' is unclear/ 03/ no problem/ the next sentence/ S16/ 08/ the word/ 02/ 'partly'/ is not known to me/ 05/ it most probably means close or half/ um/ cause it is used twice here/ S17/ 06/

I paused on/ 03/ 'the colourless space'/ 017/ I reread the sentence/ 015/ I read it again/

## Text. 2

S1/ 011/ I don't know 'survival'/ 08/ in order to understand the sentence/ 02/ I reread it/ 022/ the first part of the sentence is clear but from 'its own survival becomes unimportant'/ 03/ um/ the meaning is not comprehensible/ S2/ 07/ cause I lost my attention I read it again/ 038/ cause the sentence has some words and is lengthy/ 02/ the words are familiar but to get it better I reread it/ 013/ the meaning of/ 02/ 'death'/ is it 'date' or 'dead'/?/ unfamiliar to me/ 028/ I understood the sentence to some extent/ but cause it is a bit lengthy/ 02/ I get confused/ 02/ cause my habit is to write and jot down words of a text/ 02/ it is only then that I understand/ S3/ 038/ the sentence has both familiar and unfamiliar words/ the familiar one is 'die'/ 02/ I guess it means to die/ and the other one is 'accident'/ 02/ 'accident' and 'disease' are unfamiliar/ so to understand them I must reread the sentence/ 032/ I got it up to the middle of the sentence/ 03/ I am trapped here/ 'accident' and 'disease' are not clear to the extent that/ 02/ they cause me not to get the meaning of the whole sentence/ I reread the whole sentence/ 07/ the first part of the sentence is understandable whereas the sentence from 'but through accident' is totally incomprehensible/ S4/ 021/ this sentence due to unfamiliar words/ em/ 02/ I reread it/ 017/ here 'survives' most probably means



to be able to live/ 02/ I got it by the help of 'on chance'/ with respect to the chance of an organism survival/ 010/ by the way I don't know 'advantage'/ 013/ 'over other individuals'/ 03/ and its relation to 'advantage' and/ 03/ and the second part of the sentence is totally incomprehensible/ from 'it has' onward/ I can't get anything from it/ because of 'advantage'/ S5/ 08/ I try to interpret this small part of the sentence in order to understand the rest of the sentence/ 03/ from 'the better'/ 013/ the word 'hunter'/ 02/ I can't recall its meaning but with regard to/ 02/ 'or the faster eater'/ it most probably/ 03/ refers to eating/ 016/ I get back to the beginning of the sentence/ 033/ although I read the sentence twice/ 02/ I couldn't grasp the meaning/ S6/ 024/ 'in other words'/ this 'words' here/ 02/ it seems to me that it doesn't fit in here/ however I continue to read/ 025/ the last part of the sentence is quite clear/ what remains unknown is the beginning of the sentence/ I mean 'some individual'/ I reread the sentence/ 029/ I am looking to find some meanings for 'in other words' and 'some individual'/ S7/ 021/ I get back to the beginning of the sentence/ 08/ here I pause a bit on 'individual'/ 021/ the meaning of the sentence is not as clear as it should be/ I reread/ 018/ I got it/ cause I initially misinterpreted the verb of the sentence which was not clear at the beginning/ I misperceived/ em/ 'which are better adapted'/ I couldn't relate my initial interpretation to/ 02/ the meaning of the whole sentence/ that was why/ 02/ I had problems in comprehension/ S8/ 03/ this 'less well-adapted'/ what a grammatical combination it is / it poses a problem/ ok 'adapted' is a verb/ but what on earth does 'well-

adapted' mean? I read the rest of the sentence to see whether I can get it or not/  
016/ this sentence is rather clumsy/ 02/ I couldn't make a relationship between the  
words/ I reread the sentence to see what happens/ 035/ here I pause more/ 02/ on  
'well-adapted' and / 02/ 'to meet death'/ 03/ cause I don't know their meaning/ I  
think I can't get the meaning of the whole sentence/ 03/ but on the whole it is ok/ I  
also do not know what 'maturity' means/ but since it is a noun I guess I can draw  
the meaning of the sentence if I can know what it means/

### Retrospection

[(can I just ask you some questions?)]/ oh, yes/ [(please turn to text 1/  
somewhere in S8 you said you had difficulty in relating 'and often living food' to  
the previous sentences/ you reread it from the beginning of the sentence/ why you  
reread it?)]/ the first part of the sentence which says something about how  
phagotrophic organisms feed was comprehensible/ then the first part about  
phagotrophic organisms which are often/ 02/ 'often living food'/ this 'living' here  
is ambiguous/ [(what kind of ambiguity?)]/ grammatical ambiguity and whether it  
means more or it means something else/ [( you also had a problem with 'rotting' in  
S9/ can you guess its meaning?)]/ 06/ it is difficult to guess cause the only word  
which can help me is 'dead'/ [(in S10 you said that the words were familiar to you  
but you needed to reread the sentence/ what was the problem?)]/ I had no problem  
with the words/ but since I hadn't formed a meaning representation in my mind I

asked myself so what?/ I understand the whole picture but I cannot draw a complete picture in my mind/ [( in S17 you reread the sentence/ what was the problem?)]/ 04/ the problem was 'the colourless species'/ I tried to find an equivalent word in my mind/ [(what about 'obviously'?)]/ em/ I pay less attention to adverbs in my translation/ but 'fully' means completely that all these are heterotrophs/ organisms that/ 02/ do not have colour/ [(in sentence 2 of text 2 you said that you had problems with the sentence cause it was lengthy/ what do you mean by that?)]/ I mean regarding the fact that the sentence is made up of different pieces/ different commas/ some of its/ 02/ some parts of it were quite clear but some despite familiar words seemed to me difficult to be formed as a meaningful whole in my mind/ 02/ cause if I were to write them/ 02/ by substituting parts/ 02/ I could determine the meaning of the whole sentence/ [( in S7 of T2 you said that 'in other words' doesn't fit in the sentence/ why do you think so?)]/ 02/ 'in other words'/ 03/ I have no particular meaning in my mind/ I must read the sentence/ 29/ I am just searching for a particular meaning for 'in other words'/ I must look for 'some individuals'/ [(what if we place 'in other words' at the beginning of the sentence?/ for example/ 'in other words some individuals')]/ 03/ in this case we can translate it as in other words/ 03/ that some of its characteristics/ 02/ are valuable/ cause it is misplaced and has caused that the two sections 'have characteristics' and 'individuals' be split I can say that I had problems with it/ [(what do you think about the meaning of 'less well-adapted'?)]/ the same 'well-



*Appendix C*

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adapted'/ if 'less' is attached to the phrase it becomes three/ I don't know what 'adapted' means/ [(what are the main points of the two texts?)]/ 04/ it initially talks about the difference between plants and animals and / 04/ can I read the texts?→/ [(of course)]/ 04/ the first theme related to the difference between plants and animals/ their characteristics/ em/ it talks about the production of organic substances that animals don't do this and plants use raw materials while animals use these materials made by plants/ 04/ then it says why plants can use sun light/ it also referred to 'pigments'/ 03/ that animals lack this and only some 'euglenas' have bacterias which were not mentioned in the text/ [(thanks for you participation in this study)]/ thank you/

## **Transcription of the think aloud data revealed by SI1**

### **Text 3**

/I usually before reading a text try to get the meaning of key words and highlight them/ now in this article I highlight 'organisms' and 'evolutionary'/ then/ em/ when I highlighted them I understand that the article is about something I am going to read/ em/ then I start to read the text and try to relate the highlighted words to key words in the text/ then I start to read the text/ and when reading the text/ em/ em/ I am not looking up/ em/ em/ words in the dictionary/ when I start reading a text I check my understanding of the text/ if I get the text. that's fine/ I proceed/ then if I find difficult words in a sentence I make use of the paragraph/ usually one can guess from the beginning of a paragraph what it is all about/ based on the information in the paragraph and the relationship one can make subjectively/ I relate all together and try to guess how it makes sense/ then/ em/ when I read a paragraph and I understand it then I try to relate it to the next paragraphs/ then I see whether the two paragraphs make sense/ and I understand that what I read was ok/ If my comprehension goes awry/ I try to read the paragraph from the beginning to fully understand that section/ em/ my style of reading is that I read quickly and I don't read sentence by sentence/ when I start reading a paragraph I pass over a sentence quickly and if I find difficulty in comprehension then I try to reread the

sentence very carefully/ S1/ 06/ I read the first three sentences and I got them/  
S4/ 06/ cause it was a long sentence I had to read it again/ [(reads S3 and S4 in  
RS mode)]/ 018/ ok I was looking for the key phrase 'model organisms'/ now I  
got it/ [(automatically processes S5)]/ 04/ S6/ 06/ I got model organisms/ that  
what organisms are included in this category which is used as models for the  
systematic work/ Escherichia coli/ yeast/ maize/ etc/ 06/ then in this paragraph/  
I highlight those sections I got and specify that what this paragraph is all  
about/ [(highlights S5 and S6)]/ 03/ I read the second paragraph and try to  
relate it to the above paragraph/ em/ bearing in mind that/ em/ in this  
paragraph all words were familiar to me/ then the reason I read the sentence  
beginning with 'the idea' was that it was a long sentence which made me  
reread the sentence/ [(reads S9 in RS mode)]/ 011/ the word 'and' in S9/  
shows the relationship between these two different sections/ I had to reread it  
to see what it is referred to/ 027/ [(S10 to S11 are automatically processed)]/  
03/ I highlight S12 up to 'mechanisms' / 05/ now this sentence/ I reread the  
sentence beginning with 'potential' up to the end to get the gist/ 012/ I  
highlight S13 from 'to generalize' up to the end/ the main idea of the  
paragraph is about the difference between biologists/ those who work in the  
lab/ their approach is selection of models for evolutionary purposes and they  
choose models of 'phylogeny' or something else/ I quickly looked at those  
highlighted sections/ em/ I did this cause all this is related to each other and I



want to keep all this in my mind/ 015/ S14/ I highlight S14 from 'between' to the end/ 015/ [(automatically processes S15)]/ S16/ I highlight parts of the sentence/ 016/ here it has specified the main theme of the article/ that/ em/ it has chosen six papers about/ em/ eight organisms/ it has asked questions about the topics related to these organisms / S17/ I highlight the sentence/ and then get back and read these six questions cause I think this section is an important part of the article the first question is related to 'phylogeny'/ and the their ancestral relations among these/ then it has posed other questions about these eight organisms/ em/ and it wants to examine the evolutionary model among them/ these questions are asked here and totally the whole article is based on the answers obtained by the writers working on these models/ 016/ yes the main point is here/ um/ ok I have specified the main point so far that what it is looking for and now I can read the paragraph quicker I suppose/ [(automatically processes S17 to 21)]/ 011/ I highlight S22 from 'systematics' to 'species'/ 07/ now there is a word called 'rudimentary' which is unfamiliar to me but I can infer it from the sentence/ I don't know its Persian equivalent/ but I reread the sentence from 'phylogeny' to get its meaning/ 08/ S23/ 03/ yes it says that the 'phylogeny' of some species is better understood/ 03/ S24/ 08/ I reread this sentence to get the gist/ 09/ ...MT.../ S25/ 020/ yes here it says/ em/ on the whole what is going to be summarized/ 'summarize some of our own ideas'/ em/ the writers themselves want to express their views concerning/ em/

04/ 'systematic' and other kinds/ em/ 04/ laboratory biologists/ how those who are systematists and those who work in the labs on model organisms can assist each other/ now it wants to examine the writers' view concerning these two views/ then in this section that I want to read/ it is/ em/ giving introductory information about the paragraph/ S25/ I don't spend time on it cause I see no important points here/ cause I got the theme in the first few paragraphs that I read and I understood that what it is going to talk about/ now I am looking for that theme/ because of this I am reading quicker/ S26/ 08/ I see some words such as 'wheat'/ I need to read this section again/ 010/ I guessed the meaning of one word but now I highlight it in order to look it up in the dictionary later/ 05/ S27/ 05/ I highlight this sentence from 'systematics' to the end/ cause this paragraph wants to begin the main theme/ that/ em/ it is going to discuss a vast topic/ here probably I don't need to get back and check this word I highlighted/ cause the section in which the word is used is a trivial one/ [(automatically processes S28 to 29)]/ 020/ I highlight parts of S30 and S31/ 05/ here it says that/ em/ that if we want to do this work we must consider different organisms/ but here in order to understand the problem/ we must know few organisms well/ 05/ in order to reach our target/ 04/ then we generalize this to other things/ S32/ 03/ few of them are recognized and /now it wants to say how to select these few organism from among the others/ this is what it wants to say/ S33/ 08/ now it says that what different scientists chose/ S34/ 03/ they started



by studying organisms/ for example it says what Darwin chose/ and it is providing a 'historical background' concerning who chose what/ 013/ then it says about 'pigeon'/ that why Darwin chose it/ cause there were plenty of them there/ in England/ and/ em/ there was naturally high 'variation'/ he chose this/ then/ em/ they reached a point that/ 08/ I highlight S34 too/ [(automatically processes S35)]/ 012/ S36/ I highlight this sentence/ 'or either crops'/ this too/ their seeds are different/ S37/ 03/ and there are plenty of them/ I highlight 'mice' and 'rat'/ 03/ it nearly specified in this paragraph that it is talking about selection of organisms to be used as models and has referred to some of them/ and discussed scientists' justification for choosing them/ 08/ these were general ideas/ [(automatically processes S38)]/ S39/ 03/ then it has referred to an organism which can be relied upon in biology such as 'arabidopsis'/ and then it says why/ 03/ cause they can grow fast in the lab/ S40/ 010/ or 'xenopus' whose eggs are visible/ 04/ 'breeds often and is easy to maintain'/ S41/ 03/ it has mentioned another organism/ 't4 bacteriophage'/ 03/ 'and its host e coli remain important'/ 09/ 'molecular biology'/ 07/and then it says that they are selected at molecular level/ these are better than those/ eh/ 03/ whose organs have different parts and these are selected due to their fast reproduction and / em/ their ease of transportation/ 020/ I highlight S42/ [(automatically processes S42 to 45)]/ 034/ those who work in 'molecular biology' or evolutionary biology/ 04/ [(automatically processes S46 to 47)]/ I



reread the sentence to get its gist/ 04/ S48/ I highlight from 'it is' to the end/  
04/ S49/ 04/ this sentence is the result of the previous one/ 05/ S50/ I highlight  
the sentence up to 'life'/ 015/ [(automatically processes S51)]/ S52/ 04/ I  
reread the sentence from 'that' onward to get the gist [(reprocesses the  
sentence in RA mode)]/ 05/ again I highlight this 'hierarchical level' to see if it  
is important in my review / S53/ 010/ ok this is an important issue/ this point/  
em/ 04/ [(reads from 'nucleic acids to species' in RA mode)]/ 017/ then it is/  
03/ saying that/ S54/ 07/ 'a specific study system'/ 03/ um/ S55/ 07/ now it has  
chosen between/ 03/ 'frog'/ 'xenopus laevis'/ 06/ as a model organism in  
what?/ 'vertebrate'/ 013/ 'the neural crest'/ and 'the nature of fertilization'/ that  
this/ 03/ animals/ S56/ 03/ em/ it talks about an evolutionary topic/ in order to  
understand that this is a general pattern among amphibians / S57/ 05/ it says that  
'xenopus'/ 'a generalizable model'/ among amphibians/ 'for all'/ even it is  
generalizing it to all vertebrates/ 03/ as an evolutionary model organism among  
amphibians and then it over-generalizes it to other animals/ cause it has a shared  
characteristic with vertebrates from the evolutionary point of view/ S58 and S59/  
018/ now it says why it is important/ I highlight S59 / [(reads it in RA mode)]/  
012/ [(automatically processes S60)]/ now I read the next paragraph/  
[(automatically processes S61)]/ 018/ S62/ now this section is important in this  
paragraph/ I highlight it / S63/ 028/ now it wants to talk about those scientists who  
work in the lab and those who work on comparative biology/ em / S64/ 06/ what

characteristics they share with each other from the view point of 'phylogeny' / S65/ 013/ here it justifies its reason for the selection/ 02/ for example a comparison among organisms which are different from vertebrates/ 03/ from the view point of evolutionary culture/ they are different/ S66/ 08/ here it says something about the method of work / I rereads S66 to get its gist / 06/ it first asks a question and then tests it / S67/ 05/ I reread it cause the sentence was important/ 03/ S68/ 06/ here it says that 'phylogeny' / 03/ what it does is that it 'analyzes pattern' / [(automatically processes S69 to S71)]/ 020/ S72/ 016/ now it talks about the differences among them/ em/ I think this part wants to attract the reader's attention/ [(rereads the sentence in RA mode)]/ [(automatically processes S73 to S74)]/ 021/ S75/ 03/ I highlight this sentence / S76/ 06/ I highlight this sentence/ S77/ 09/ I think this section beginning with 'therefore' is very important in regard to the whole article/ therefore I pay more attention to it/ I reread the sentence from the beginning to get the gist/ [(automatically processes S78 to 79)]/ 027/ S80/ 05/ from the genetic point of view it has chosen a model/ 03/ and says that how from the evolutionary point of view/ em/ it is talking about genes/ em/ it has chosen/ em/ 'arabidopsis' / and/ S81/ 020/ it has taken an analytic view and has said something about plants and flowers/ S82/ [(reads the sentence in RA mode up to 'angiosperms')] / 08/ organisms which are naturally flower or 'normal' / it is comparing their genetic similarities/ 06/ then it has discussed 'gymnospermous ancestors' from the evolutionary point of view/ in order to find the origin of angiosperm flowers/ to



get information to discuss their ancestors/ S83/ 04/ then it relates it to 'phylogeny'/  
03/ I highlight this section cause it is important / [(automatically processes S84 to  
86)]/ 025/ S87/ 09/ I highlight this sentence/ S88/ 016/ I highlight the sentence  
from 'to describe' to the end / S89/ 07/ it has discussed two more organisms/  
'ascomycete' and 'schizosaccharomayces' / S90/ 036/ / I read up to 'species'/ now  
I want to reread S91/ 06/ there is a need for collaboration between systematists  
and those who are engaged in experimental works/ to discover this / S92/ 07/ I am  
highlighting this sentence / S93/ 09/ here it is discussing the results of the studies/  
it says that a new door is opened/ 05/ for the synthesis of the genes/ 05/ that all  
three data in one system / [(automatically processes S93 to S94)]/ 015/ [(reads S95  
in RA mode)]/

## Retrospection

[(I noticed that you did not report your thought processes on a number of  
sentences/ nor did you give an interpretation of them/ what was the reason?)]/  
well/ to be honest it may be due to my habits in reading/ I read quickly  
sentences that I think I understand/ you know/ em/ that's why I forget to  
report/ [(you mean that you read them automatically?)]/ something like that/  
[(can I ask you some more questions?)]/ sure/ [(looking back to S12 you said  
that you read the sentence to get its gist/ what did you get?)]/ em/ 017/ ok, I  
think the thing is that / em/ I think it says that laboratory biologists understand



the way that evolution occurs among organisms/ and/ em /models of phylogeny reconstruction/ [(in S31 you said that in order to understand the problem we must generalize few well-studied organisms to other things/ what are those things?)]/ 018/ from the evolutionary point of view we can generalize few such organisms to other organisms/ for example if we want to study vertebrates or other animals we see that these animals are very wide/ then cause they have something in common in terms of evolution process/ we choose some organisms and try to know them fully/ ok/ then we generalize them to other animals/ 04/ one of the problems is that/ em/ scientists and those who work in the lab they have to feed each other/ the systemtalist whose main job is to classify the organisms should get help from the biologist who work in the lab/ to understand the organisms/ [(what was the main idea of the text?)]/ I got the main idea by looking at the key words of the title/ I knew what I was looking for/ then I started to read paragraph one/ by a meticulous look at the highlighted sections I found that in order to account for the evolution of different species we must take some particular organisms as models/ organisms which can cover a wide range of animals and to be generalizable to other animals/ it showed what organisms serve better for this purpose/ at the end of the paper three important points are mentioned/ these serve as the basis of organisms evolutionary studies/ [(why do you highlight?)]/ usually when something is interesting and necessary to know I highlight it/ I highlight the

sections I want to refer to later/ [(you said when you read aloud you pay attention to pronunciation and therefore it is disruptive of your comprehension/ is it the case when you read for yourself?)]/ when I read for myself it interferes with my understanding/ when I read a text I must delve into it / I didn't know that you were paying attention to my behavior/ it is very important/ I was reading naturally the same way I normally read when I am alone/ [(thanks for your participation)]/

### **Transcription of the think aloud protocol data revealed by S12**

#### **Text 3**

/S1/ [(reads up to S7 in RA mode)]/ it says that Mendel used peas/ then Morgan used *Drosophila* and other scientists used other things such as nematode in order to make a model/ to use it for basic investigations in molecular biology/ S8/ [(reads up to middle of S12 in RA mode)]/ I don't know what 'controversies' means/ I read forward/ [(reads S12 in RA mode)]/ I didn't get this paragraph as good as the first one but in general it says that the attempts are important steps in systematizing these investigations/ these issues/ they are working in different laboratories and probably the heart of the matter/ 03/ lies in systematizing the investigations/ I feel a bit difficulty with the paragraph/ I reread S8/[(reads in RA mode)]/ 04/ a small number of/ a small group of scientists/ 03/ are studying a large

group of organisms/ 03/ [(rereads S9 in RA mode)]/ 03/ these/ these laboratory models have been used as tools for further research/ [(reads S11 in RA mode)]/ 03/ um/ so far/ it seems clear/ 03/ that there must be common ground for these/ I don't know the meaning of 'disparate'/ for these groups of biologists/ I probably don't know what 'disparate' means/ may be it refers to separate groups/.....MT...../ S12/ 'laboratory biologists understand mechanisms potentially explaining how characters evolve the mechanistic basis of ~~~~~ / and a host of other issues that lie at the heart of' / um/ it says/ um/ biologists using the standard mechanism/ understand/ um/ using this/ I think using the present mechanisms/ 07/.....MT...../ I don't get much from this sentence/ 'laboratory biologists understand mechanisms potentially explaining'/ it potentially explains/ that how/ em/ that these characteristics/ these qualities/ how these qualities 'evolve the mechanistic basis'/ 'evolve'/ I just can't recall what it means/ am I reporting everything?→/ [(oh, yes, that's great)]/ 'the mechanistic basis'/ 02/ the mechanistic basis/ I don't know this 'convergence' too/ 02/ 'and a host of other issues that lie at the heart of controversies' / em/ there are some words with which I am not familiar/ for example I don't know 'phylogeny'/ 'reconstruction' means to construct again/ I really don't get much from this sentence/ 'homology'/ em/ I know this word/ but I can't get the sentence/ can I read the next sentence?→/ [(yes, please)]/ S13/ 'systematists understand<sup>RA</sup>

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relationships and history'/ the people who have classified/ em/ the people who are working on biological issues believe in better understanding of relationships/ to understand the history of biology/ 'they can provide the historical framework necessary<sup>RA</sup> to generalize the results from particular model systems to an appropriately broad or narrow array of organisms'/ 02/ it is in regard to this relationship and this history that the scientists can provide a framework for modelling these relationships in an appropriate way/ whether in a broad or a narrow way/ they know the importance of these relationships/[(reads S14 in RA mode)]/ 05/ it says that a group of systematists were invited in a symposium/ 03/ to discuss their views with those who work in laboratory/ and who design models/ that they can / em/ convey <sup>-----></sup> their views about the importance of the models / [(reads S15 in RA mode)]/ 04/ O.K./ 03/ it says that they chose a series of different organisms/ em/ 03/ 'phylogenetic'/ aha/ 'phylogenetic'/ I don't know what it means/ 04/ *I have got another feeling/ anyway/* 'that spans a broad phylogenetic and biological spectrum and contacted colleagues who are in touch with both groups of researchers'/ anyway/ they prepared this set of organisms/ that the two groups of the researchers can contact each other/ 03/ S16/ 'eight organisms were<sup>RA</sup> discussed'/ in six papers eight organisms were discussed/ 03/ 'dealing with <sup>RA</sup>Zea, fungi, drosophila, xenopus. axolotl and mus'/ WFWT/ I don't know 'axolotl'/ 'in this issue of systematic<sup>RA</sup> biology comprise the written results of

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this effort'/ the result of this symposium is given in this issue of systematic biology/ S17/ 'in these papers we asked each author to discuss a series of topics on -----> each organism'/ we asked each author to discuss the organisms they have worked on/ 03/ important topics/ 03/ S18/ 'what is known of its<sup>RA</sup> phylogenic relationships'/ 03/ I know that this 'phylogenic' comes from genetic/ this 'phylogenetic' is / 03/ a bit unknown to me/ the question was that what known relationships existed with 'phylogenetic' / 03/ S19: 'why is the organism a valuable<sup>RA</sup> model in the laboratory?'/ why organisms/ these small<sup>RA</sup> microscopic creatures -----> / no matter what we call them/ why they have such value in laboratory works/ 02/ S20/ 'how can the detailed<sup>RA</sup> mechanistic information on that organisms be used to further systematic research'/ 02/ 'and how can the phylogenetic position of the organism<sup>RA</sup> be used to guide comparative laboratory work?'/ ok/ how can/ um/ it be detailed/ the information obtained from these organisms/ these small creatures/ to systematize/ or to classify them/ 02/ for future research/ 'and how can<sup>RA</sup> the phylogenetic'/ *phylogenetic must be those kind of organisms/ I am sorry/* 02/ it may be those small creatures which are genetically abnormal/ can go under mutation/ this might probably mean phylogenetic/ ok/ 'be used to guide<sup>RA</sup>'/ that we can use them in laboratory research/ due to their quick genetic changes/ *might*



be/ due to this characteristics these microscopic creatures/ 03/ are/ em/ important elements or 'materials' in laboratory works/ that we may use them in our further research/ and can/ 02/ generalize them to larger organisms/ 02/ *might be* [(reads S21 in RA mode)]/ 03/ various papers/ 02/ in various papers what was important/ those ideas that can be helpful/ this/ em/ this/ em/ that these organisms/ these known organisms/ these/ 02/ small known creatures/ probably this 'depending' says that this depends on these small microscopic creatures/ that we see them and understand what characteristics they reveal / and/ um/ 'orientation'/ or mutation/ that direction/ what can I say/ the tendency/ em/ 03/ the tendency that we have in understanding these creatures / that firstly we must know them/ the creatures which we investigate/ and secondly to see what we are looking for/ what issues must be systematized/ that's what I got/ S22/ 'in most cases'/ WFWT/ 'the systematics has lagged↗'/ 'lagged↘'/ *I don't know this word*/ 02/ 'far behind <sup>RA</sup> the bench work'/ in many cases the systematics/ the basis of their work relates to/ that is depends on laboratory work/ 'for several species'/WFWT/ 'arabidopsis'/ it is the scientific name of a cabbage/ ....MT...../ 'the phylogeny is so rudimentary that no clear direction for comparative studies can be provided at this time'/ for plants/ em/ the 'phylogeny'/ again I think it refers to the same quick change/ whatever it might be/ changes are inevitably genetic/ 03/ it is not quite known that we can compare them/ em/ 03/ other organisms/ em/ however/ we cannot make

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full use of it at the moment/ what nonsense interpretation I am making out of the sentence/ LFV/ S23/ 'for others'/ those who were mentioned before/ 04/ 'the phylogeny appears to be somewhat better understood'/ the 'phylogeny' is understood better/ therefore the arabidopsis as an organism and as a laboratory work poses problems to the investigator/ S24/ 'in all cases'/ WFWT/ 'the need for broad interactions among research groups is a missing ingredient that should be ~~~~~ added' / 06/ ah/ in any case really/ 03/ an interaction/ em/ a wide interaction between different research groups/ 02/ it is felt that this must be added/ an interaction must be established between different groups of researchers/ and this unfortunately is 'a missing ingredient'/ this still/ 03/ is not a settled issue among the research community/ S25/ 'in the remainder of this paper'/ let's see what the rest of the paper wants to say/ 'we briefly summarize some of our own idea on why systematists and laboratory biologists can and should help each other in the quest'/ 02/ 'for general patterns and <sup>RLV</sup> mechanisms in biology'/ it says that these research groups/ 03/ I am still thinking about 'phylogeny'/ ok/ it says that in the remainder of the paper they want to summarize different ideas/ to say their own ideas/ 03/ systematists/ 02/ and those working in labs/ laboratory biologists can ~~~~~ and must help each other cause they must propose a general plan / in relation to mechanisms in biology/ it is natural if I cannot express my understanding of the text fluently/ [(reads S26 in RA mode)]/ it says that they are optimistic about

systematizing plants/ that is/ em/ this wheat/ and 'zebrafish'/ 'zebra' is donkey/  
LFV/ ass/ now this 'zebrafish' can be translated as assfish/ LFV/ now then/ em/  
they can use this as an important factor in revolutionizing biological sciences/ this  
was the gist of the sentence/ mind you/ I don't want to paraphrase all/ [(reads S28  
in RA mode)]/ 03/[(reads S29 in RA mode)]/ we can't really investigate all  
organisms individually → / it is really *waste of time!* and it is not manageable  
to investigate all species/ S30/ 'if the goal of most work in biology is a mechanistic  
understanding of how organisms and their constituent parts work then almost any  
organism will do as a research tool'/ 03/ if the goal of most biology work is to  
really understand how organisms work/ 02/ and to know what relationship exists  
between different parts of them/ 03/ then each organism can be used as a research  
tool/ [(reads S31 in RA mode)]/ this is / 03/ and important point/ that we must  
understand it/ that/ em/ that a small number of organisms can/ in this world/ to be  
suitable tools/ things to be used in biological work/ [(reads S32 in RA mode)]/  
how can these be used as models → / S33/ 'many were chosen<sup>RA</sup> initially because  
they were both accessible and variable'/ I got the gist of the sentence/ S34/  
'Darwin began the origin of species with a discussion of artificial selection in  
pigeons'/ 'pigeons'/ I don't know this word/ 'a good model because there are  
plenty of pigeons in England and the strains mimicked naturally occurring  
variation'/ the model was used cause there were many 'pigeons' in England/ S35/

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'drosophila'/ I want to report very briefly/ [(reads S35 in RA mode)]/ this is because of rotting fruits/ [(reads S36 in RA mode)]/ and this due to plants/ em/ cause there were plenty of seed/ seed is everywhere/ or weed/ S37: 'mice and rats have always been plentiful around human habitations'/ 02/ this is completely clear/ [(reads S38 in RA mode)]/ this explains about recent models/ S39/ 'arabidopsis'/ I don't know if it is still under investigation/ 'is easy to breed and grow in the lab'/ 03/ S40/ I don't know what 'xenopus' is / 'is handy'/ it can be handled easily/ 'because it has large visible eggs, breeds often and is easy to maintain/ 02/ I got it/ [(reads S41 in RA mode)]/ I got it completely/ cause it is related to the investigations which some of my friends are involved in / it is a bacteriophage that can be changed in the lab and respond to the laboratory experiments/ it could easily be screened too/ S42/ 'although accessibility and tractability are important the ultimate rationale for using model organisms depends on the ability to generalize to other organisms'/yes/ 03/ I must read it again/ although 'accessibility' and 'tractability' are important/ 03/ although availability and 'tractability'/ attraction/ *might be*/ I assumed that this comes from 'attractive'/ availability and attraction may be important factor but at the end/ it is hoped that this can be used as a model for other organisms/ I returned back to the sentence cause I didn't get it well/ 04/ [(reads S43 in a RA mode)]/ 06/ now many/ I don't want to paraphrase/ many labs use things which are 'agronomic'/ things that are agricultural/ they have justified its use/ [(reads S44 in RA mode)]/ this also talks



about how it could be used as a model system/ 'which can only be estimated<sup>RA</sup> in a comparative context'/ that can be compared and be competitive with other things/ 02/ [(reads S45 in RA mode)]/ it says a group of fellow scientists/ 02/ that the cellular department tries to search for commonalities/ to complete future research and give guidelines/ [(reads S46 in RA mode)]/ I got it/ [(read S47 in RA mode)]/ I read the previous sentence again/ 'the recognition<sup>~~~~~</sup> of commonalities'/ the recognition/ the recognition of this commonality/ common grounds/ aha/ it refers to the works whose origin are from comparative work/ S47/ 'the laboratory models'/ the laboratory models can be compared/ its basic aspects important for the same commonalities/ S48/ 'this approach is obviously powerful'/ um/ [(reads to the end of the sentence in RA mode)]/ I completely understand it/ [reads S49 in RA mode)]/ um/ 03/ S50/ 'the commonalities at this level are synapomorphies<sup>~~~~~</sup> of life or at least of kingdoms'/ um/ I don't get this sentence/ 'the commonalities'/ common/ em/ 'are synapomorphies<sup>~~~~~</sup>'/ I don't get much/.....MT...../ 'or at least'/ or at least of kingdoms/ now/ 'synapomorphies'/ 'morphy'/ it means shape/ common shapes/ symmetrical/ something like that/ I know 'morph' and 'poyomorphic'/ 'synaptus'/ it may be 'synaptus'/ something like that/ something comes to my mind/ [(reads S51 in RA mode)]/ I understand it/ S52/ 'characters evolve leading to shared similarities that vary across a nearly infinite number of hierarchical levels'/ 03/ 'vary across a nearly infinite number of hierarchical level<sup>~~~~~</sup>'/ I don't

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*know* 'hierarchical'/ I don't really get the sentence because of this word/ 03/ I read it from the beginning/ [(rereads in RLV mode)]/ 04/ finally it says about things that have something in common/ things that have similar commonalities/ 'vary across a nearly infinite'/ they are completely 'infinite'/ they are known/ aha?→/ 'infinite'/ they determine 'number of hierarchical level'/ 03/ they can determine 'hierarchical' levels/ what is this 'hierarchical' ↯?/ LVF/ harmonic levels/ they can be grouped under one category/ if I had access to dictionary I would certainly look it up/ S53/ 'certain characteristics such <sup>RA</sup> as nucleic acids for encoding genetic information'/ I got it completely/ 'are constant across life whereas others are restricted to a single species population or individual'/ S54/ 'herein lies the/ 03/ 'dilemma'/ 'dilemma' ↷/ em/ em/ I think we have two ways in our dilemma/ 02/ that we don't know which is which/ *might be*/ 'herein lies the dilemma in applying the results from model organisms'/ this 'herein' is a noun/ we are uncertain about which to choose as a model/ 05/ 'dilemma'/ ok/ [(reads the rest of the sentence in RA mode)]/ S55/ 'thus'/ therefore/ 'the clawed frog'/ aha/ *may be Xenopus is a frog*/ 03/ frog/ 'has become one of the premier models in vertebrate developmental biology'/ frog may become the first model/ I don't know this 'vertebrate'/ 'and studies of the structure of the neural crest and the nature of fertilization rely on'/ ok/ this may be useful for neural structures/ 'and the nature of fertilization'/ reproduction/ natural reproduction/ 'rely on generalizations based on this single



amphibian'/ 'amphibian'/ what?/ aha/ flies/ 'amphibian'/ I got the gist of the sentence/ S56/ 'however from a phylogenetic and morphological perspective'/ nonetheless/ now I don't want to paraphrase/ from the point of view of morphology/ 'xenopus is member of basal extremely modified family of frogs that are unique and <sup>~~~~~</sup>bizarre in most aspects of their biology'/ it is very important from the perspective of genetics and morphology/ this frog which we want to use it as a model is a modified form of the frog family/ S57/ 'is xenopus a generalizable model for all vertebrates'/ can it be a general model for all other 'vertebrates'?/ 'vertebrates'/ *I don't know it!* 03/ for all other organisms/ LFV/ I really don't know/ I don't really understand/ it may refer to mammals/ oh no / it couldn't be a mammal/ <sup>~~~~~</sup>'an anomalous taxon' 7/ 'taxon'/ it shouldn't be *toxin*/ 'that is not even a very good example of a normal frog'/ can it be for example/ 04/ as a / 02/ 'taxon' can probably come from 'taxonomy'/ as a model in classification/ as a model in 'anomalous' classification/ I don't know 'anomalous'/ 05/ 'is not even a very good example of a normal frog'/ I don't know what 'anomalous' is/ 04/ even it is not a good model as a frog/ LFV/ so what/ can it be used as a good model?/ [(reads S58 in RA mode)]/ the answer depends on the characteristics of this creature/ what properties it has/ [(reads S59 in RA mode)]/ for the neural system/ probably this 'migration'/ this neural movement/ I don't know 'crest'/ it can be a suitable model/ [(reads S60 in RA mode)]/ for the biomechanic feeding/ it can have a unique



characteristic/ 03/ it can be recognized from those that are tongueless/ 'aquatic tongueless'/ *might be*/ tongueless/ LFV/ without tongue/ LFV/ that can be used as a model for very little/ 04/ the whole paragraph is talking about whether it can be used as a model for all others/ that was the main idea of the paragraph/ then it says its characteristics/ that this frog can be used as a weak model for others/ [(reads S61 in RA mode)]/ 'the power of model organisms thus comes from the enormous amount of detailed'/ 04/ 'specific data accumulated by a large community of scientists'/ 07/ I want to read it again/ 'the power of model organisms'/ yes/ 'thus comes from the enormous amount of detailed'/ therefore a suitable model must be powerful in its details/ it needs an enormous amount of details/ 05/ we really must gather all the characteristics/ the scientists gather these characteristics to reach a conclusion which help them to decide which model to choose for all others/ S62: 'the weakness comes from the relative *paucity*'/ I don't know 'paucity'/ 'of comparative data'/ um/ 'combined with the lack of a good phylogenetic framework to guide the assembly of those data'/ it says about the shortcomings of the investigation/ now the weakness/ in relation to/ 04/ comparison of data/ 03/ data that together/ the relate data/ it may be that/ it says that the weaknesses may be related to the respective data/ however I don't know this 'paucity'/ probably it refers to weaknesses/ I don't really know what it is/ that these do not have a suitable framework to guide us to see where we want to go/ now my main weakness is this 'paucity'/ I skip it/ [(reads S63 in RA mode)]/ ok/ S64/ 'moreover

the laboratory-based scientists have generally not exploited the power of phylogenetic data for framing comparative questions'/ I read this section again/ 07/ they have not been able to gather an extraordinary information about the power of phylogenetic data/ 'for framing comparative questions'/ for this framework/ what can I say/ these questions/ to categorise these questions/ 'in part because of a difference in vocabulary an approach between work on a single species and work on a large group of organisms'/ it is talking about how to use large groups of organisms/their vocabularies are different and we cannot classify them within a framework → / [(reads S65 in RA mode)]/ ok/ 03/ the nature of the questions can be different in the same manner that nature of our observations is different/ em/ 'evidence'/ what can it be?/ signs/ different achievements/ [(he skips S65 and S66)]/ S67/ 'multiple experiments can give answers that are (largely) unambiguous' / 05/ 'multiple experiments'/ WFWT/ now/ 04/ can it really answer the questions/ 05/ 'give answers that are (largely) unambiguous'/ 'unambiguous' ↗/ I don't know its meaning/ em/ em/ probably it refers to wishes/ I don't know its meaning/ 'unambiguous'/ it probably refers to 'ambition'/ it just came to my mind/ S68/ 'the phylogeneticist'/ the people working on this/ [(reads to the end of the sentence in RA mode)]/ they have analyzed a design/ S69/ 'the experiment was a cladogenetic event'/ 04/ S70/ 'the challenge is to discern'/07/ 'what might have happened'/ the problem is to see what might happen/ [(reads to



the end of the sentence in RA mode)]/ I got it / [(reads S71 in RA mode)]/ I read it again/ 06/ 'hypotheses emerge'/ WFWT/ these really/ em/ hypotheses come from small things and not from definitive experiments/ it is absolutely known to me/ 03/ [(reads S72 in RA mode)]/ I think the scientists pay attention to general ideas in each other's disciplines/ [(reads S73 in RA mode)]/ it is quite clear/ 02/ [(reads S74 in RA mode)]/ I completely understand it/ [(reads S75 in RA mode)]/ yes/ S77/ 'it is now possible to identify phenotypes'/ meaning frame/ 'that mark cladogenetic'/ I don't know this 'cladogenetic'/ 04/ 'phenotypes'/ I got it/ [(reads S78 in RA mode)]/ it is therefore possible to know/ 03/ the changes/ at mechanistic levels/ [(reads S79 in RA mode)]/ I got it completely cause this relates to my field/ completely/ [(reads S80 in RA mode)]/ other things are published elsewhere too/ [(reads S81 in RA mode)]/ I got it completely/ 04/ 'putative orthologues having a similar effect have been identified in snapdragon'/ 03/ 'putative orthologues'/ I know 'putative' which means things which are known/ 'ortho'/ it means multidimensional/ 'logus'/ means things that are 'logged' together/ I don't know its Persian equivalent/ 'having a similar effect'/ having similar results which help us recognize what was in these flowers/ sometimes I don't understand/ this seems to me natural/ /S82/ 'the wide distribution<sup>RA</sup> of these genes'/ WFWT/ 'suggests that they may affect the identity of floral organs'/ these genes are so distributed that they may help us to find them in all other organisms/ 'they may thus provide a new tool with which to address the origin of the



angiosperm flower from its gymnospermous ancestors'/ aha/ 'gymnospermous'/ it means gymnospermous/ 'angiosperms'/ means angiosperms ↲?/ aha/ it is angiosperms/ this genetic method can be of great help → can be used as a suitable instrument for identifying gymnospermous flowers/ this paragraph wants to say that we can use genes in order to systematize other organisms and using genes is nowadays accepted as a way of showing common evidence among plants/ 04/ [(reads S83 in RA mode)]/ ok/ I read it again/ 03/ I got it now/ [(reads S84 in RA mode)]/ LFV/ S85/ 'systematics is based on the <sup>/premaiz/</sup>premise'/ I don't know this word/ I can't understand the sentence/ I read it again/ 03/ um/ it say that systematics can be based on this/ 05/ 'more distantly'/ distant relatives/ 'more distantly related'/ those organisms that are distant relatives/ 'are the less they have in common'/ are less than those that have common characteristics/ that they can together/ 03/ distant families/ 03/ their similarities/ let us say/ are less/ 03/ 'they are the less they RLV have in common'/ 03/ the problem is that I don't know this <sup>/premaiz/</sup>premise'/ [(rereads the whole sentence in RA mode)]/ 03/ probably their differences are less than their commonalities/ they have more in common/ however it is still unclear/ S86/ 'thus when the one-organism-per-kingdom approach uncovers differences it becomes necessary to <sup>/diskern/</sup>discern'/ I don't know what 'discern' is/ 'at what level the differences lie'/ an organism separates/ it is not necessary to know at what level this separation occurs/ S87/ 'Taylor described cases where a difference between

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drosophila and shccharomyces'/ 02/ 'might naively be interpreted as difference between animals and fungi'/ Taylor has said that drosophila and the other organism are basically/ that it is possible/ 03/ that their difference was between animal and fungi/ we don't know in which group they should be put/ should we put them under the animal category/ 'naively'/ what does that mean?/ I guess it refers to basis of something/ [(reads S88 in RA mode)]/ S89/ 'however study of another ascomycete'/ 'ascomycete'/ *might be a kind of fungi*/ 'schizosacharomyces shows that the differences must have appeared somewhere'/ this shows that the difference might have occurred somewhere else/ 'in the lineage leading to yeast itself' / in <sup>/linkeij/</sup> 'lineage'/ meaning linkage/ em/ genes link to each other/ that is/ em/ synonym/ it may be wrong/ that is they are connected/ in yeast/ [(reads the rest of the sentence in RA mode)]/ in this case its characteristics are similar to those of animals/ [( read S90 in RA mode)]/ there is a need for more samples/ [(reads S90 in RA mode)]/ the last paragraph is conclusion/ it says if we want to design a model we need two things/ one is the need for collaboration between those who work in laboratory/ work on material/ and are experimental scientists/ 07/ and systematists/ [(reads S92 in RA mode)] / this '~~~~~'/ 'purview of the scientist grounded in the model species'/ I read it again/ RRA/ 03/ the main role in this regard is played by the systematist/ although the two groups should collaborate with each other/ 'whereas the purview'/ I don't know its meaning/

'view' means point of view/ probably 'purview' refers to that/ 'of the scientist grounded in the model species'/ 03/ [(reads S93 in RA mode)]/ a new door is opened to new scientists/ those who want to work in genetics, development and systematic/ S94/ 'the challenge <sup>/kolig/</sup> '/ 03/ these three sources of information need collaboration between the two groups/ 03/ [(reads S95 in RA mode)]/ 03/ species which can be used as a model/ 02/ they can be as a vehicle/ a factor for/ 'such a synthesis'/ for constructing this collaboration/ that causes evolution/ and 'allow development'/

### Retrospection

[(in some parts of the text you asked yourself questions/ why did you do that?)]/ oh yes for example here I saw drosophila/ so when I really do not understated I try to find a sentence/ to read a sentence/ 03/ If again I fail to get it I will go and have quick look at the whole paragraph/ I put aside those words that are not worth looking/ I don't have any difficulty with the texts that are in my field/ when my mind is not in the text when I reach the end of a paragraph/ due to my lack of attention I ask myself what it was all about/ I get the main idea as soon as I get back to the paragraph/ cause I read it with understanding/ [(what does the text want to say in general?)]/ it says for research/ no matter what to call it/ we need a model / these models must firstly be simple/03/ the same 'phylogenic'/ they must be swift and simple/ like the drosophila example/ just like the other examples/



mouse and the rest/ they must be available/ models/ models/ em/ must be user-friendly/ models must be known unambiguously/ like arabidopsis/ so in order to systematize/ and those who work in labs with the models must be quite realists/ they must have complete contact with each other and exchange their data in order to form a model/ then we can select one model and generalize it to all other models/ that's what I understood/ some models are suitable for some reasons/ but they may not be suitable for others/ the example of frog/ it is good from some point of view/ but a weak model from another perspective/ other factors may play a role/ therefore to make a revolution in biology we need a model/ models must be known/ systematists and experimental biologists must collaborated with each other/ the models must be generalizable/ to what?/ to other organisms/ now/ um/ 03/ genetic systematics and development/ these can collaborate with each other to make a model in biology and to work on this basis/ [(you read some sentences in RA manner/ why did you read aloud?)]/ oh ya/ cause it gives me more concentration/ [(your explanation of some sentences was not clear/ for example in the case of S22 you laughed at your interpretation/ please tell me what the reason was)]/ let me look at it/ 06/ oh yes/ em/ when things get difficult I cannot express what the sentence is all about/ that might be the reason why I laughed/ [(thank you very much for you explanations)]/

### Transcription of the think aloud data revealed by SI3

**Text 3**

[( The subject automatically processes sentences from 1 to 8)]/ S9/ I look up 'explore' in the dictionary/ 018/[( S10 to 11 are automatically processed)]/ I look up 'convergence' in the dictionary/ 019/ I get back to read S12/ 034/ [(S11 to 14 are automatically processed)]/ I reread S15/ [(S16 to S17 are automatically processed)]/ S18/ although I know 'phylogenetic' I can't recall it now and I look it up in the dictionary/010/ I reread S18/ 013/ [(S19 to S20 are automatically processed)]/ 016/ S21/ 016/ 'lagged'/ I can't recall 'lagged'/ I look it up in the dictionary/ 014/ I get back to the beginning of the paragraph/ 024/ S22/ I stop at 'phylogeny' and I reread the sentence/ I am just concentrating on the sentence cause I think the sentence is important/ [(S23 to 24 are automatically processed)]/ S25/ 'convince' seems to be familiar but for the time being I have no idea about it/ I get back to the beginning of the sentence/014/ I read S26/ 012/ I am concentrating on 'diversification' and 'cladogenesis'/ 010/ I reread the sentence/ 024/ I stopped at 'provide' and reread the sentence/ 03/ S27/ 010/ cause I lost my attention I read the sentence again/ 013/ [(S28 and S30 are automatically processed)]/ 020/ S31/ 017/ I get back the beginning of the sentence/ 010/ I reread the sentence/ 010/ [(S32 to S34 are automatically processed)]/ 023/ S34/ I don't know 'accessible' therefore I look it up it in the dictionary/ 013/ I reread the sentence from the



*Appendix C*

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beginning/ 03/ [(S34 to S37 are automatically processed)]/ 045/ S38/ 011/ I am completely concentrating on the sentence/ 05/ I look up 'tractability' in the dictionary/ 014/ I reread the sentence from the beginning/ 023/ I read S39/ 011/ I get back to the beginning of the sentence/ 015/ [(S40 to S41 are automatically processed)]/ 012/ I read S42/ 09/ I reread the sentence/ 020/ again from the beginning of the sentence/ 016/ I reread from 'the ultimate'/ 011/ [(S43 is automatically processed)]/ 08/ I read S44/ 010/ I get back to the beginning of the sentence/ 010/ I read S45/ 07/ I don't know 'mission'/ I look it up in the dictionary/ I guess it comes from 'missed'/ I get back to the beginning of the sentence/ 016/ [( S45 to 46 were automatically processed)]/ 030/ I got back to the beginning of S 46/ 026/ [(reads S47 to 51 automatically)]/ 036/ I reread S51 again/ 020/ [(reads S52 and S53 automatically)]/ I read it again/ 030/ [(reads S53 automatically)]/012/ now I read S55/ 013/ I don't know 'clawed' and I feel I need to refer to the dictionary/ S56/ 015/ I reread the sentence/ 012/ [(reads S57 to S60 automatically)]/ 025/ I read S61/ 017/ I reread it/ 06/ I knew 'paucity' but I have forgotten it/ I use dictionary/ 015/ I reread the sentence/ [( reads S62 automatically)]/ 09/ now I read S63/ 010/ I look up 'trove' in the dictionary/ 014/ I reread the sentence/ 05/ [(reads S64 automatically)]/ 025/ I read S65/ 017/ I reread the sentence/ 07/ S66/ 015/ I look up 'unambiguous' in the dictionary/ 018/ I reread the sentence/ 018/ [(reads S68 to S70 automatically)]/



I am reading S71/ 07/ I reread it/ 07/ now S72/ 026/ I look up 'delve' in the dictionary/ 019/ I reread the sentence/ 017/ [(reads S73 to S75 automatically)]/ 037/ I read S76/ 016/ I reread the sentence/ 025/ now I am reading S77/ 023/ I reread the sentence/ 017/ [(reads S78 to 80 automatically)]/ 029/ I read S81/ 018/ I look up 'putative' and 'snapdragon' in the dictionary/ 038/ I reread the sentence/ 021/ [(reads S82 automatically)]/ 017/ and now S83/ 014/ I reread the sentence/ 010/ [(reads S84 automatically)]/ 05/ I am reading S85/ 014/ I reread the sentence/ 010/ S86/ 011/ I reread the sentence/ 012/ I read S87/ 026/ I reread the sentence/ 014/ now S88/ 016/ I reread the sentence/ 022/ [(reads S89 automatically)]/ 033/ I read S90/ 024/ I don't know 'accurate' and look it up in the dictionary/ 019/ next paragraph/ [(reads S91 automatically)]/ 013/ I read S92/ 013/ I reread the sentence/ [(reads S93 to S94 automatically)]/ 023/ now S95/ 010/ finished/

### **Retrospection**

[(what would you say about the main idea of the text?)]/ it has compared two approaches in the paper/ 04/ to improve the organisms/ all creatures on the whole/ one approach deals with experiment/ and kingdom experiments/ another approach/ 03/ relates to experiments outside/ and those who ran laboratory experiments/ it has compared the two groups evaluating how these groups can help each other/ whether they accept each other or not/ that/ 03/

and to obtain a kingdom/ the top of a kingdom and a member of each group of animals can be of help/ 02/ in overgeneralizing them to other animals in the same family/ that whether examination of one organism can lead to an overgeneralization of that organism to other organisms in the same group/ and /em/ finally it says that there is a difference between their approaches and the texts they use/ 02/ this has caused a divergence of views which do not tolerate other opposing approaches/ 02/ but/ 03/ totally it says that we can overgeneralize from one organism to other organisms/ 03/from one family to other families/ [(you reread S9 in the second paragraph/ why?/ why do you basically reread a sentence?)]/ 05/ I think it is a concluding remark/ 03/ it has summarized the paragraph above that/ 04/ it has made a conclusion/ 03/ that / 02/ why we actually try to select these kingdoms and models for our work/ em/ 06/ that we then understand that we need tools for our research/ that/ em/ 04/ in order for us to analyze our organism/ [(you reread S12/ what was the problem?)]/ 05/ I had a problem in sentence understanding/ I mean there were few words which I didn't know/ all of them appearing in the same sentence/ this causes a problem in understanding/ that I couldn't match the words/ 03/ generally I know its literal meaning/ but how to relate them together/ [(he starts reading the sentence in RA mode)]/ I can't really relate these sentences to each other/ it has got complex and difficult words/ all appearing in a long sentence/ [(therefore length of a sentence is important)]/ oh ya/ it is an



inhibiting factor/ [(but apparently this mustn't be the case cause you reread S18 which is a rather short sentence)]/ 04/ the reason is because of comprehension problems/ cause/ 03/ these variables/ models that we use/ 04/ in our lab/ my mind flew to the idea that why we should use this organism in the lab/ I wanted to know why we should use this model in the lab/ 02/ to know the question was my purpose/ I pay attention to the questions in the text/ [(why did you reread S21?)]/ oh yes/ this was a sentence/ 08/ the purpose of rereading was to understand the second part of the sentence/ I mean after the comma/ I reread in order to understand the second part of the sentence/ [(what do you think about your problem?)]/ 07/ I just didn't understand/ even now that I am reading I think I need /04/ some concentration/ 011/ although I now got it/ [(in S26 you paused on 'diversification and cladogenic'/ why?)]/ 09/ this really/ this variation/ em/ perhaps this means context/ 03/ what?/ this didn't come into my mind/ the thing I expected/ 04/ [(you read S31 three times/ why?)]/ 012/ this is a key point in the text/ this really shows an important point in the whole text/ it didn't have an experimental example but was representative of the writers' view/ 03/ that can be a point of understanding other organisms that can be overgeneralized to a bigger society/ [(you skipped some sentences/ why?)]/ I suppose that some part of the text is general/ that is I had already got them/ this caused me to skip those parts that I though were reflecting a general review of the text therefore I avoided them/ [(thanks for your participation in the interview)]/



## Transcription of the think aloud data revealed by S14

### Text 3

[(reads S1 to S6 in RA mode)]/ here there is a scientific name/  
'caenorhabditis'/ however I know it is a member of 'nematodes'/ I got what is  
says/ [(reads S7 to S10 in RA mode)]/ ok perhaps it is necessary to read the  
sentence again but I would think that I need not/ [(reads S11 in RA mode)]/  
06/ but it has talked about two groups that I didn't get them in my first  
reading/ probably I get the point more clearly from the subsequent sentence/  
[(reads S12 till 'independence' in RA mode)]/ I almost didn't understand what  
it says/ 04/ aha/ now this makes the previous points clearer/ it explains that /  
03/ in fact phylogenic models/ the structures of phylogeny which is in fact the  
ancestral structure among them/ and 'homology' which is their common  
feature/ it says that the organisms have such common features/ this makes the  
text clearer for me/ I mean if I get back and reread I will certainly understand  
the main purpose of the sentences/ probably/ [(reads S13 in RA mode)]/ again  
this makes the previous sentences clearer/ that they are looking for some  
common features among the groups that have common homology and family  
relationships/ [(reads S14 in RA mode)]/ ok this sentence also makes the  
previous sentences which I passed lightly clearer / I know what is going to be

focused/ [(reads S15 and S16 in RA mode)]/ I didn't get this sentence/ [(reads S17 to S20 in RA mode)]/ 04/ ok the questions proposed here are quite clear/ and I know what they are looking for and what sort of answers they want to get/ [(reads S21 to S22 in RA mode)]/ ok it is quite clear/ [(reads S23 to S24 in RA mode)]/ I nearly didn't get it and it is probably necessary to get back but I disregard it and move forward/ S25/ 'in the remainder of this paper'/ probably lack of concentration caused me not to understand it/ exactly this sentence/ so the reason I didn't get it was lack of concentration/ [(reads S25 to S26 in RA mode)]/ I got the point and no problem at all/ [(reads S27 in RA mode)]/ this 'both groups'/ em/ is still unknown to me/ that/ who is which/ I can certainly get the point if I get back and reread the previous sentences/ but now due to certain conditions I disregard it/ [(reads S28 to S37 in RA mode)]/ the sections are absolutely clear/ [(reads S38 to S39 in RA mode)]/ again it is clear although I am not familiar with this species I still know what they are looking for/ [(reads S40 to S41 in RA mode)]/ it's quite clear/ [(reads S42 in RA mode)]/ again here I paused on the second word/ I know 'accessibility' but I think 'tractability' has a similar meaning to 'accessibility'/ meaning that the organisms we select as models should be simply handled and fed/ therefore although I don't know the word it is not important cause I can get the gist of the sentence/ [(reads S43 in RA mode)]/ I don't know 'agronomic'/ again cause I was thinking about the things I explained to you I lost my attention/



[(reads S44 to S50 in RA mode)]/ it is necessary to understand this paragraph cause it is changing its topic and reviewing the things accurately/ that is the question of systematics in regard to cell and molecules/ I had to reread this paragraph if I wanted to read this text/ [(reads S51 to S52 in RA mode)]/ ok this sentence/ sometimes a word has a special meaning such as this 'hierarchical level'/ I don't know it/ I paused here because of this/ cause I wanted to know what it is/ [(reads S53 to S54 in RA mode)]/ I nearly didn't understand this two sentences/ I said to myself to leave the first sentence and read the next/ now I think I must reread the two sentences/ [(reads S55 to S56 in RA mode)]/ ok this is clear to me/ I feel easy with the text particularly those sections with which I am more familiar/ [(reads S57 to S58 in RA mode)]/ this last sentence which is posing the question should be reread to see why 'frog' is classified at taxonic level/ I must reread the sentence/ [(rereads S58 in RA mode)]/ now the sentence makes clearer that part of the sentence which posed problem to me/ it is explaining about the migration of cells of 'neural crest'/ in 'xenopus'/ ok/ this sentence is making the previous sentence clearer/ [(reads S60 to S62 in RA mode)]/ 04/ I should reread this sentence to see what it really says/ in fact I disregard the sentence to see what happens next/ [(reads S63 in RA mode)]/ again here/ 03/ this refers to the same groups/ probably it refers to the same previous groups/ the same biologist group which used to follow comparatively and those who worked in systematics/ the two groups I



mentioned earlier/ I don't know 'avail'/ I should find it in the dictionary/ now I think/ perhaps it refers to this two groups/ now in order to check if it is ok/ the second reading could prove it/ but if I had read it I would have got whether it refers to it or not/ 04/ ok/ [(reads S64 to S69 in RA mode)]/ I didn't get this sentence/ therefore I totally disregard it/ I nearly didn't get anything from the last three sentences/ therefore I read the next sentence to see if I can get anything/ [(reads S70 to S72 in RA mode)]/ again I still don't understand them/ meaning that/ 03/ em/ if it were another situation I would have reread them to get rid of the problem/ [(reads S73 in RA mode)]/ I reread this sentence to stop the problem to proceed/ what then are the most important ways in which laboratory and phylogenetic research programs can and should communicate/ [(rereads the sentence)]/ aha now I got what it means by asking this question/ [(reads S74 to S81 in RA mode)]/ I reread this last sentence/ 'putative orthologues having a similar effect have been identified in snapdragon and in maize'/ ok/ in fact it has confirmed the point raised above/ [(reads S82 in RA mode)]/ here it refers to an evolutionary fact/ it suggests whether plants such as angiosperm flowers and gymnospermous flowers are the origin of other plants/ now I skip 'gymnospermous'/ but now it says that these evidence show that angiosperm flowers are the ancestors of gymnospermous plants/ something like that/ [(reads S83 to S85 in RA mode)]/ I reread from the beginning of the paragraph/ [(rereads in RS mode)]/ 027/

[(reads S86 in RA mode)]/ I reread the sentence/ [(rereads in RS mode)]/ 013/  
ok/ [(reads S87 to S90 in RA mode)]/ the whole idea is that based on the  
genetic differences we can determine the place of different groups in the  
genetic tree/ I got it and there is no need to get the details/ I got the message/  
[(reads S91 in RA mode)]/ it's quite clear/ [(reads S92 in RA mode)]/ I reread  
the sentence/ [(rereads in RS mode)]/ 012/ there is one word which has a key  
role in this sentence/ I don't know that word and therefore I don't know what  
the sentence says/ [(reads S93 and S94 in RA mode)]/ [(rereads S94 in RS  
mode)]/ 09/ [(reads S95 in RA mode)]/ I reread this last sentence again/  
[(rereads S95 in RS mode)]/ 05/ ok I got it/

### Retrospection

[(what is the main idea of the text?)]/ it is all about model making and the use  
of other species/ and finally it is based on structural similarities on which  
molecules and genes are based/ we can use them and get the phylogeny of the  
organisms and their homology/ [(why did you reread S73?)]/ 012/ questions  
are posed in texts/ to me these are important to see where they are guiding me  
to/ thus I would miss the rest of the text if I didn't understand the questions/ so  
I pay more attention to such questions/ [(do you leave a sentence that you  
don't understand aside?)]/ no no/ I leave aside those sentences which are  
trivial/ [(do you reread or return to a paragraph whose sentences are not clear

to you?)]/ it depends on whether the paper is important/ that is if it is important I ignore nothing/ and if it requires rereading I would reread it many times/ [(on the other hand if it is trivial and not critical)]/ oh yes/ I may ignore the parts which I do not understand/ [(you read S92 several time why?)]/ when a paper comes to its end the writer wants to conclude/ this is the paragraph which carries the conclusion/ thus it is important to get the gist of three pages in one paragraph/ the writer gives guidance and implication for further research/ I think one must give more importance to it and pay more attention to it/ [(did this session cause you any excitement?)]/ at the beginning yes/ just like in an exam session / I have always been like this/ I feel anxious at the beginning but as time goes by I feel relaxed/ during this session I was sometimes thinking about my explanation to you/ that was why I sometimes missed sentences/ even the mere expression such as I got it affects my concentration on reading the subsequent sentences/ I would have a better understanding of the text if I didn't have to explain it to you/ [(thank you very much for your contribution to this experiment)]/

### **Transcription of the think aloud data revealed by S15**

#### **Text 3**



[(reads the whole first paragraph automatically)]/ 035/ um/ the main idea of the first paragraph is that they have used certain organism as models in order to determine the rest/ all the rest/ then I skipped the rest/ cause I understood it/ aha then I understood that these organisms are Escherichia coli yeast maize and another sample/ I highlighted them to see what they are going to do with these models/ cause for example/ 03/ in our lab we make use of cells especially Escherichia coli/ this is an appropriate model for genetic investigation/ it is very beneficial/ it can be of great help for the genetic investigation/ and now it is used widely/ cause it has a simple genetic structure and can be easily recognized/ ok/ [(reads the second paragraph)]/ 038/ it is talking about two groups of scientists/ that I didn't understand their differences/ I continue the paragraphs and I guess that it can be clarified at the end of the paragraph/ but I should tell you one thing that I don't forget that I may get back to the beginning of the paragraph and search for my lost idea/ I reread the paragraph again/ 020/ LFV/ ok/ it has talked about one group of scientist at the end of the first paragraph and in the second paragraph it has talked about the second group and in the middle of the paragraph now it has put the two groups in a face to face position/ each group has his own idea about the laboratory models/ I think I'd better read the next paragraph/ 013/ 'symposium' has attracted my attention/ I highlight the symposium/ 038/ it is talking a bit about the details of the symposium/ that eight organism are

discussed/ I highlight all these/ 029/ they have asked the scientists several questions/ or 'topics'/ I highlight all these questions to see what they were sensitive to/ [(reads the next paragraph)]/ 030/ the arabidopsis sample/ 024/ [(reads the next paragraph)]/ 042/ there are several words whose meanings are not clear to me and I think that they are interesting/ I underline them for the next reprocessing of the text/ 'wheat'/ 'zebrafish'/ 04/ I don't see their relationships in the paper/ 035/ I read the next paragraph/ 052/ I thought that this paragraph is interesting but I found that it is not/ I read the next paragraph/ 012/ I highlight the first sentence/ em/ I highlight the two following words 'accessible' and 'variable'/ interesting/ 012/ the word 'pigeon'/ am I pronouncing it correctly?→/ [( 'pigeon' )]/ aha/ what does it mean?→/ [(it means pigeon)]/ pigeon/ 014/ 'drosophila'/ 017/ I read the next paragraph/ I faced a word that I don't know its meaning/ 'tractability'/ I refer to the dictionary/ I underline it/ 014/ I highlight 't4 bacteriophage'/ I couldn't get the last sentence in this paragraph/ I reread it/ 012/ [(reads the next paragraph)]/ I have to know these two words cause they are repeated here/ I know 'accessibility'/ it means to be accessible/ 'tractability'/ I look it up in the dictionary/ 013/ aha/ it is interesting/ S41/ 05/ in this paragraph/ em/ I've encountered 'rationale' several previous times/ 03/ I had already looked it up in the dictionary/ and now it has escaped from my mind/ I continued the sentence and at the same time I started to guess its meaning/ em/ in the meantime I said to myself that it must come from 'rate' and it may

mean relative/ but still I have it in my mind and continue the sentence to see if it is interesting I refer back to the dictionary/ 014/ S43/ I highlight 'medical' and 'agronomy'/ 038/ at the end of the paragraph they talked about this approach/ I read the previous sentences and suddenly asked myself which approach is meant here/ for this reason I reread the sentence from the beginning/ S45/ I reread the sentence/ S48/ 'synapomorphies'/ I highlight it to see what it is/ [(read the next paragraph)]/ 030/ I don't know 'hierarchical model'/ what does that mean?→/ [(hierarchical)]/ aha/ hierarchical/ I also don't know what 'dilemma' means/ 026/ S55/ 09/ I underline 'xenopus' and 'clawed frog'/ S56/ 049/ 'bizarre'/ 'bizarre'/ or 'bizarre'/ what does it mean?→/ [(it means unusual)]/ 'bizarre'/ 020/ here in this sentence it says that 'xenopus' is a good model for 'neural crest'/ I know neither 'neural' nor 'crest'/ does it here mean cross↯?/ does it mean multiplication↯?/ 'crest'/ 'migration' means to transfer/ 'neural'/ jumping move↯?/ zigzag/ 'neural'/ 020/ 'tongueless'/ they don't have tongue too/ I must know the meaning of 'neural crest migration'/ 'neural' has something to do with the nerves/ 'crest' means additional/ it may also mean cross/ but what does 'migration' mean in the sentence↯?/ 'neural crest migration'/ ....MT..../ 'crest' also means emblem/ however lets skip it and see what it says in the end/ [(reads the next paragraph)]/ 060/ 'the difference is between conducting experiments'/ this 'conducting experiments'/ 'conduct' means to contact/ 'conducting experiments'/ contact experiments/ it is interesting/ I'd better refer to the original paper/ S67/ 06/ I



don't know the meaning of 'unambiguous'/ I guess it means vague/ or something important/ but I do not know its real meaning and I think that I don't need to know it/ 069/ I read S70/ I reread it /030/ I read S76/ 050/ I highlight 'cladogenetic' to see what it is/ now S79/ I highlight 'a set of genes' whose reference is given here and if it is interesting I highlight the title of the paper/ 030/ S82/ I read the sentence once and I read it once up to the middle of the sentence/ I then decided to highlight it and I do it because to see it another time/ [(reads the next paragraph)]/ 052/ ok/ in this sentence it talks about two kinds of species/ 'drosophila' cause it wants to talk about some important things later on/ I did not pay attention to this word/ I want to see what it is going to say later on/ I am reading 'might naively be interpreted'/ 015/ S89/ I underline the word 'lineage' to guess its meaning later on/ 010/ oh/ here it has paid attention to an example/ 'introns'/ it has said that in one of the 'introns'/ but 'introns' is a problem for me/ therefore I both underline and highlight it/ S90/ [(reads the whole sentence in RA manner)]/ and the last paragraph must relate to concluding remarks/ S91/ [(reads the whole sentence in RA manner)]/ 010/ 'systematists' and 'experimentalists'/ 05/ LFV/ it reminds me of something/ 03/ it reminds me of an event when I was doing my Msc in Islamic philosophy/ that a group of philosophers look the world holistically while the other group sees it from a narrow angle/ I think the writers have referred to that distinction/ S92/ [(reads the sentence up to 'purview' in an RLV manner)]/

'purview' 7/ does it refer to 'pure' 8/?/ does it mean pure view 8/?/ 04/ 'scientist grounded in the model species'/ 03/ I think it means landscape/ 010/ S93/ [(reads the whole sentence in RA manner)]/ S94/ [(reads the whole sentence in RA manner)]/ S95/ [(reads the whole sentence in RLV manner)]/ um/ ok/ I now highlight the last sentence/

### Retrospection

[(why did you highlight the topic of the symposium in paragraph three?)]/ cause it is going to discuss the topic of the symposium/ that is about the models/ secondly in case I find something interesting to continue, the topic will help me search /that I can make a key board from the symposium and give it to computer or any other system to get further information/ that is why the topic was important to me/ [(somewhere in the text you read in RA and RLV mode, why did you do that?)]/ I think I do this particularly when I /02/ the text lingers here and there in my mind/ I read a bit louder to attract my attention and focus more/ then I delve again into the text/ [(in sentence 33 of paragraph seven you highlighted 'accessible' and 'variable' and said that they were interesting/ why?)]/ because only these two characters are selected from among others/ only because of these two characters/ that is important then/ cause I want to reprocess them/ it came to my mind that why the writers haven't looked for other characters/ why were these two important together/

now I may be able to tell the reason why they have chosen these two/ yet they seemed to me interesting/ [(what is the main idea of the text?)]/ 05/ the main idea/ 03/ is about / 03/ two views about laboratory models/ and research/ that these models/ that these organism models are used for different purposes/ and it is reflecting different views/ it has introduced a symposium/ and em/ 04/ it is interesting/ its has contrasted the two groups/ if this was my work I would reread it quickly to see what I have gotten from it/ 04/

### Transcription of the think aloud protocol data revealed by S16

#### Text 3

/ ok/ [(reads the title)]/ the paper deals with model organisms in evolutionary studies/ um/ the two writers of the paper are from famous American Universities/ em/ I read the paragraph sentence by sentence/ [(reads S4 in RS mode)]/ 05/ and/ um/ their main aim was to find a model organism that/ um/ to find a model to be used for genetic investigations for others/ 09/ the results have been absolutely successful and/ um/ they have been usable/ 05/ the laboratory studies of cellular biology/ molecular/ um/ which are potential in applying/ em/ to use laboratory organisms for/ um/ it is applicable and it says that using 'E coli'/ to use E coli/ um/ 03/ 'maize' which is corn/ nematodes frogs mice/ these are the animals that are used in genetic investigations/ [(reads S8 in RS mode)]/ consequently a lot of



scientists started investigating to find answers for the genetic questions by examining a limited number of organisms/ the first paragraph talks about different animals used for evolutionary genetic investigations/ [(reads S9 in RS mode)]/ 04/ in classifying the organisms/ in systematics in contrast to the previous paragraph which talked about a limited number of animals in evolutionary studies/ here a vast range of animals are studied by the scientists/ animals and not organisms/ [(reads S10 in RS mode)]/ 013/ um/ the importance of the laboratory animals for classification /03/ organisms/ for the scientists working in this field/ um/ it is not a known subject/ now they have decided to select a model organism to be used as a research tool/ this is not specified and/ 02/ not known/ [(reads S11 in RS mode)]/ 07/ em/ 03/ therefore there is a special difference between the field work of these two groups of scientists/ the groups like the systematists who work on organisms and the groups who are working on hereditary genetics/ evolutionary genetics/ [(reads S12 in RS mode)]/ 023/ ok/ cause the sentence is long/ I dissect the sentence and discuss each section separately to relate them together/ the biologists who work on laboratory organisms/ um/ they generally cover basic investigations and work on general aspect of the organisms/ [(reads from 'the mechanistic' to the end in RLV mode)]/ there is one sentence about which I cannot give more information/ however it relates to modelling/ um/ 'phylogeny'/ hereditary/ and/ um/ 02/ and 'homology'/ this means that they discuss if each of the samples has a

relationship to each other or not and how their phylogenies/ um/ are related to each other/ [(reads S13 in RS mode)]/ 04/ those who work on systematics they see the relations/ um/ 02/ among ~~~~~ 'individuals' / individuals/ and study their history/ and provide a network/ a 'framework' for their phylogeny/ 011/ then they move from a vast class of systematics down to a limited class of systematics in order to study the organisms' phylogeny/ the discussion in the second paragraph relates to the differences in the way the two groups of the scientists tackle the issue of biology/ those who work on systematic genetics/ and a group of scientists who/ um/ 03/ work on phylogeny and sexual and evolutionary subject/ and the organisms studied/ the organisms used for the first group are laboratory organisms but for the second group the organisms are real whose phylogenies are studied/ [(reads S14 in RS mode)]/ 017/ it says about a seminar with the systematics scientists in regard to selecting a model organism/ [(reads S15 in RS mode)]/ a number of organisms/ 04/ used by the biologists were discussed and their phylogeny/ 'phylogeny'/ um/ and their relations and their biologic positions in the evolutionary system were discussed/ um/ 05/ the seminar then gathered the data presented by both groups/ [(reads S16 in RS mode)]/ 06/ eight organisms were discussed and six papers under the title of systematic biology that/ um/ 03/ their results are published/ the eight organisms are/ 04/ maize 'fungi' fungi frogs/ I don't know what 'axolotl' is/ they discussed all this/ [(reads S17 in RS mode)]/ 04/ in these papers topics about the above organisms are discussed/ [(reads S18 in RS

mode)]/ 019/ um/ 06/ it says about the phylogeny of the organisms/ and where these are located/ why this organism can be a valuable model/ um/ 08/ um/ 012/ and how the details and their phylogenic structures can be used for continuing the systematics investigations/ um/ in regard to that organism/ um/ and the situation of that organism/ um/ as a model for other laboratory works/ this paragraph mainly reflects the attempts taken by the writers to bring together the views of two groups of scientists for/ um/ selecting a model organism/ [(reads S21 in RS mode)]/ 012/ um/ in various papers these subjects about each organism are deeply discussed/ 05/ with a tendency toward a particular species/ [(reads S22 in RS mode)]/ I think 'lagged' comes from 'lay'/ however I am not quite sure/ 04/ it says that in all these investigations/ systematic/ I'd better use systematics/ that systematic is discussed regardless of their 'bench work'/ 025/ here we have this word 'rudimentary' / probably it means/ probably it means fundamental/ I am not quite sure but I guess it may mean that/ and the sentence says that for many species/ um/ the phylogenic relation discussed has a /um/ theoretical and fundamental status/ um/ and our direction for comparative studies is not very clear/ at least it is not clear at the present time/ [(reads S24 in RS mode)]/ 013/ ok/ the last sentence is the conclusion of the whole paragraph/ um/ it says that this relation circle is missing and is needed/ 'from a broad interaction among research<sup>RA</sup> groups is a missing ingredient that should be added'/ the paragraph explains the position of each



organism referred to in the above papers/ LFV/ it discusses their role as a model organism and their results/ can I continue the text?/ [(yes, please)]/ I don't know if I am doing well/ or you have any suggestion/ [(that's all right)]/ I pause on 'remainder'/ I wanted to know what it means/ is that the same 'reminder'/?/ I have confused it with 'reminder'/ 014/ um/ 05/ I have never encountered 'remainder'/ but now I can recall 'remain' which means remain/ it is the product of the investigation/ probably we can interpret it as what remains/ [(reads S26 in RS mode)]/ 015/ I read the first part of the sentence/ 020/ 'in so doing' is a bit understandable/ probably it means with regard to what we have so far done/ our hope is that/ that it can be/ 05/ an evolutionary mechanism/ I was looking for an appropriate equivalent for the mechanism/ that this refers to species differentiation/ or 'diversification and cladogenesis'/ I don't really know what the last word means/ but I guess the sentence is talking about the root of the organisms' kingdom/ [(reads S27 in RS mode)]/ 010/ em/ 05/ I need to read it again to translate the sentence to you/ this is because I want to recall what I read/ I usually do this particularly with long sentences/ 04/ it says some of the problems/ vague factors that/ the attempts of most investigators concerning introducing a special model/ a special organism model that can bring the views of these two groups of scientists closer/ [(reads S28 in RS mode)]/ 06/ this is a fundamental subject/ 'fundamental'/ [(reads S29 in RS mode)]/ 012/ I read this sentence cause I wanted to relate it to the previous sentence/ 'and for many questions it<sup>RA</sup> would be

a waste to do so'/ and it is waste of money/ [(reads S30 in RS mode' and translates it)]/ [(reads S31 in RS mode)]/ my understanding from this paragraph is that the writers want to direct the reader about the fact that it is not needed to investigate all organisms in our biology laboratories/ and that if we choose two three or four model organisms and focus our attention on these organisms/ we can then generalize the results to other organisms/ um/ in this way we do not spoil our time/ [(reads S32 in RS mode)]/ 04/ [(he sighs)]/ [(reads S33 in RS mode)]/ 05/ [(reads S34 in RS mode)]/ 016/ [(reads S35 in RS mode)] 04/ [(reads S36 in RS mode)]/ 06/ [(reads S37 in RS mode)]/ 04/ a plenty of this rat or mouse can be found in England/ this paragraph is mainly oriented towards the previous work on model organisms/ and/ um/ its origin comes from Darwin/ it wants to say that the three or four models/ be it plant or animal have responded to systematics investigations/ I think the writers have expressed the theme here more fluently than in previous paragraphs/ the sentences are clearer than the sentences in the previous paragraphs which tended to compress few subjects in one sentence/ consequently/ 02/ its translation was a bit difficult/ 04/ but in this paragraph in spite of a long sentence/ I mean S34/ I could easily understand it/ cause only one subject was targeted for discussion/ [(reads S38 in RS mode)]/ 016/ in other models particularly those which are used recently/ um/ they are selected mainly because of their use in laboratory works/ 'arabidopsis' is probably a plant/ I don't really know its scientific name/ [(reads S41 in RS mode)]/ 013/ in this paragraph different

*Appendix C*

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organisms selected as model are discussed/ [(reads S42 in RS mode)]/ 015/ I didn't get this latter part of the sentence/ I read it again/ 04/ [(reads S43 in RS mode)]/ 010/ [(reads S44 in RS mode)]/ this characteristics or this phenomenon/ that this organism/ this organism which is selected as a model/ em/ I need to read this sentence again/ 'this applic<sup>RLV</sup> ability/ the ability to apply/ this model organism based on the comparison between this and other organisms/ we can infer its suitability as a model organism by comparing it with other organisms/ [(reads S45 in RS mode)]/ 010/ a colleague in this department took the responsibility of coordinating all this/ Mr. Gilbert who is a very distinguished figure/ [(reads S46 in RS mode)]/ 05/ [(reads s 47 in RS mode)]/ 012/ um/ 06/ I read this sentence again cause I want to relate what is in the parenthesis to the rest of the sentence or at least separate it from the sentence to be able to interpret the sentence/ and they do this comparison in their kingdom/ 'across kingdoms'/ [(reads S48 in RS mode)]/ [(reads S49 in RS mode)]/ 04/ when I was reading this sentence something came to my mind/ I don't really care about the date of the publication of this paper/ um/ 1993/ um/ probably it is a high classification of systematics/ I was thinking to the seminar which I recently took part when I was reading the sentence/ I was informed in the seminar that a newer method has recently been discovered which is newer than what is presented here and can be used as a tool for systematics biology/ my mind flew to that seminar/ [(reads S50 in RS mode)]/ 07/ it talks about positive similarities/ 'synapomorphosis'/ of life among different kingdoms/



the main points in this paragraph is that/ following the previous paragraph which says that different model organisms can reveal new information about the total evolutionary systems of all organisms/ that they can herald that information/ [(reads S51 in RS mode)]/ I have so far tried to avoid translating the sentences word by word/ that's why I sometimes skipped some words/ I hope that it is a good strategy/ [(reads S52 in RS mode)]/ 09/ there is a word here which strikes my attention and that I haven't seen it so far/ 'hierarchical'/ 'hierarchical'/ I don't know its meaning/ nevertheless I read the following sentence to see what I gain/ that similar differences at level/ 'to shared similarities that vary across a nearly <sup>RLV</sup>infinite number of hierarchical levels'/ this is important here/ 'to shared similarities'/ I don't know what it is/ I skip this sentence to see what comes next/ [(reads S53 in RS mode)]/ 014/ ok/ this sentence was easier to read/ it says about special characteristics such as nucleic acids or 'DNA'/ which 'encode' genetic characteristics of any individual/ em/ this is constant during the whole life/ [(reads S54 in RS mode)]/ 018/ I don't know what 'dilemma' means in spite of a second reading/ I read it twice/ I don't have any special meaning for it/ but in the whole the sentence says that considering the characteristics of this model/ em/ organism/ I should say that/ em/ one needs to understand the distribution of individual ~~~~~ characters among this population/ [(reads S55 in RS mode)]/ 017/ this sentence is a long sentence/ it says that frog/ .....MT...../ the clawed frog is different from the

frog we find in a farm/ its neural system is discussed based on generation system/  
'generation'/ [(reads S56 in RS mode)]/ 011/ it says that frog is a member of  
'<sup>/baʒal/</sup>basal' / I don't know '<sup>/baʒal/</sup>basal' / 04/ I don't know what to call it/ I have seen this  
word before but I cannot recall it know/ I didn't have problems in understanding  
the sentence but I couldn't paraphrase it well/ cause to find synonyms in Farsi for  
such words is a bit difficult/ it is possible that one gets the sentence but when it  
comes to paraphrasing and expressing what the whole sentence is all about then  
one has to find an appropriate meaning for words in the text/ I am only expressing  
my understanding in an unedited form/ this is a rough translation of what I  
understand from the sentence/ if I listen to the tape I will certainly change some  
parts of it/ my pauses are due to finding appropriate equivalents for words in the  
text/ [(reads S57 in RS mode)]/ [(reads S58 in RS mode)]/ [(reads S59 in RS  
mode)]/ 06/ em / somewhere in the text I said that this 'neural crest' as a neural  
system/ apparently I made a mistake/ 'neural' means neutral/ 'crest'/ I don't know  
what it means/ 'neural <sup>RA</sup>crest migration'/ migration/ 03/ I don't know/ probably I  
can get it by reading the next sentences/ [(reads S60 in RS mode)]/ 06/ the main  
idea of the paragraph is that an organism with regard to its characteristics can be a  
model/ considering some of its common phylogenic characteristics which it has  
with other organisms/ but sometimes an organism has a special characteristics that  
is not found in other organisms/ this characteristics then can be generalized to



other organisms/ [(reads S61 in RS mode)]/ 08/ [(reads S62 in RS mode)]/ 05/ this weakness/ this weakness against that ability/ it refers to the ability which an organism shows when it wants to select/ em/ in relation to comparative data obtained from this organism/ I read this sentence again / 05/ I don't really know what 'paucity' means/ it may influence my understanding of the sentence/ but I tried to reduce its influence/ [(reads S63 in RS mode)]/ 016/ [(sighing)]/ it says that comparative biologists/ biologists who compare/ evolutionary biologists/ or systematist biologists/ 09/ um/ no/ it couldn't be systematists/ cause these are separated from each other later/ I don't know two words in this sentence/ one is 'trove'/ 'trove'<sup>RA</sup>/ [(reads S64 in RS mode)]/ 015/ it read the sentence again cause it was a long sentence/ 08/ to translate the sentence I read it bit by bit cause I couldn't get the sentence/ em/ [(reads S65 in RS mode)]/ 04/ [(reads S66 in RS mode)]/ 07/ [(reads S67 in RS mode)]/ 09/ I don't know the meaning of 'unambiguous'/ or at least I cannot recall it now/ cause the word is too familiar to me/ the sentence however says that various experiments have given reliable responses/[(reads S68 in RS mode)]/ 012/ [(reads S69 in RS mode)]/ 011/ these experiments/ em/ are events which happened in a far past/ and do not recur/ the word 'cladogenetic' is repeated here again/ 03/ I said earlier that I didn't know its meaning/ it probably refers to something in the past/ probably it refers to the past history of genetics/ I only reckon/ [(reads S70 in RS mode)]/ 08/ [(reads S71 in RS



mode)]/ 05/ it says that it is the results that make up hypotheses in systematic works and not the mere laboratory experiments/ [(reads S72 in RS mode)]/ 05/ this paragraph is fairly longer than the previous paragraphs/ here the paragraph discusses the difference in the perspectives of two groups of scientists/ the phylogeneticists and laboratory scientists/ it explains the kinds of organisms and the scientists' attitudes towards them/ the paragraph talks about the organisms tangibly/ it explains the organisms on the basis of the characteristics of each organism their similarities to each other and their relationships in terms of their kingdoms/ in general their 'vocabulary' is different/ [(reads S73 in RS mode)]/ 010/ [(reads S74 in RS mode)]/ 05/ [(reads S75 in RS mode)]/ 09/ [(reads S76 in RS mode)]/ 010/ em/ I said that I don't know this 'cladogenetic'/ but based on the few sentences I read I guess it refers to some external characteristics/ and attributes/ em/ that are signs for 'cladogenetic'/ em/ such characteristics can be compared and their similarities/ 03/ can be understood by comparing them with the characteristics of other organisms/ [(reads S78 in RS mode)]/ 09/ [(reads S79 in RS mode)]/ 07/ [(reads S80 in RS mode)]/ 08/ [(reads S81 in RS mode)]/ 014/ two other plants are found to have a similar set of genes/ em/ 'snapdragon' and maize/ [(reads S82 in RS mode)] 014/ I am not familiar with these two genetic terminologies/ however the paragraph discusses a link between these two groups or scientists/ their first job was to find data/ the data specify characteristics of each organism which can be compared to other animals/ this in turn provides us with

better understanding of that organism/ in general from the information gathered from their phylogenetic and kingdom status/ and the example which the writers gave we understand that a set of genes for producing a plant is found/ then another set of genes similar to this set of genes has been found in different floral organs/ and it has been found that they are not only phenotype but genotype as well/ the next paragraph will discuss the second link of this approach/ [(reads S83 in RS mode)]/ 07/ [(reads S84 in RS mode)]/ 03/ [(reads S85 in RS mode)]/ 011/ [(reads S86 in RS mode)]/ 014/ I need to read it twice/ 011/ em/ [(reads S87 in RS mode)]/ 010/ Taylor has explained the difference between *Drosophila* and *Saccromyces* which is a fungus/ a yeast/ and has made a difference between the two/ one as an animal and the other as a fungus/ *Saccromyces* as a fungus and *Drosophila* as an animal based on the ifferences observed in their characteristics/ I didn't know the meaning of 'naively' but I could get the sentence/ [(reads S88 in RS mode)]/ 014/ it's a fairly long sentence/ I reread the sentence/ I think my concentration is lessened possibly because I am reaching the end of the task/ LFV/ 010/ this group/ this presentation/ this interpretation/ places that/ 'places the change<sup>RLV</sup> at a specific point' it places/ this interpretation places the changes related to a particular species 'the change<sup>RA</sup> at a specific point'/ a specific point at an evolutionary time/ ok/ so the sentence means that this interpretation/ this interpretation/ this interprets a certain point in evolutionary time/ it specifies its



*Appendix C*

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position/ 03/ in order to interpret/ to explain/ to clarify the differences at a kingdom level/ 07/ and/ em/ em/ em/ 'a very precise<sup>RLV</sup> and unsupported claim'/ in order to confirm/ 03/ it means to emphasize/ 03/ to make it accurate / to make more detailed in relation to this unproved or unsupported claim that says about the distribution of the characters/ the meaning of the sentence/ the position of each difference in characteristics or 'phenotype' or in evolutionary time can form different levels of kingdoms/ and/ em/ 03/ it talks about the distribution of the characters/ that was the meaning of the sentence/ [(reads S89 in RS mode)]/ 012/ this too is a fungus which shows that the difference should become explicit where/ 09/ this linkage relates to yeast/ where they become yeast/ the difference lies there/ 'this fission yeast has the animal character state e.g., introns present rather than<sup>RLV</sup> absent as in *Saccharomyces*'/ aha/ [(reads S90 in RS mode)]/ 05/ the main idea relates to the second link/ the link that connects this two groups of the scientists/ em/ now let me summarize it/ 013/ the characteristics of each organism in relation to kingdoms and their differences must be studied/ and based on these similarities and differences we can get their phylogenetic and systematic status/ it is the job of the laboratory biologists/ while the systematics biologists compare the characteristics of these organisms/ this was the second link/ [(reads S91 in RS mode)]/ 05/ [(reads S92 in RS mode)]/ 08/ it says which characters must be put within this 'taxa'/ group/ classification/ em/ the decision rests with the systematist/



whereas the scientists working on model organisms are responsible to examine the nature of the experiments/ [(reads S93 in RS mode)]/ 05/ [(reads S94 in RS mode)]/ 05/ all information must be complementary/ 'so that the different approaches can<sup>RLV</sup> be mutually reinforcing'/ so that the differences are tackled and solved effectively/ [(reads S95 in RLV mode)]/ 05/ this paragraph concludes everything/ it says that three groups must work with each other and share their information/ and together make a model or a system in order to find other missing links among organisms/ and the model organism can be of great help in this regard/

## Retrospection

[(why did you read in a low voice part of S12 from 'mechanistic basis' onward?)]/ sometimes in order to concentrate I read aloud/ it helps me to concentrate/ that is I use my auditory comprehension as a helping factor/ when reading aloud for myself I try to get rid of any distraction/ it sometimes happens and it is quite unconscious/ [(sometimes you laughed when reading/ for example in S24)]/ 014/ LFV/ oh yes/ this is unfortunately the missing ingredient circle among scientists/ unfortunately scientists are unable to understand each others' problems/ meaning that they have formed a circle around themselves that cause them not to understand others' problems/ and this lack of communication exists and since it was already known to me and I saw it was repeated here then I laughed/

[(occasionally you said that you really wanted to translate/ for example in S27 you said that you needed to read it again to translate the sentence / what do you mean by translation?)]/ I really did not want to translate/ by translation I meant paraphrasing the sentence/ however to paraphrase a sentence in the first language requires one to translate the gist of that sentence/ you know what I mean/ [(you sometimes put stress on some words/ what was the reason?)]/ I did it quite unconsciously/ I don't see any reason for doing this/ [(thank you very much for your participation in this study)]/

### **Transcription of the think aloud data revealed by S17**

#### **Text 3**

[(reads S1 to S5 in RS mode)]/ 050/ here it says that mandel used peas for genetic investigations/ morgan used drosophila/ and delburk used t4/ the idea was to learn how to study this special work/ to introduce a model/ that this model/ 03/ was a success for the laboratory works/ em/ and studies/ em/ these studies show the molecular and cell biology/ [(reads S6 in RS mode)]/ 09/ models such as the ones mentioned here including 'arabidopsis' which is a kind of cabbage/ these models were used as model organisms/ and the result of this investigation was to respond to basic biological questions/ the main idea of the paragraph is generally about the kind of organisms we are using as model organisms for the basic biological questions/ [(reads S9 to S11 in RS



mode)]/ 055/ here we have systematics/ meaning classification/ in systematics/  
I mean/ 03/ a small number of scientists have done a vast investigation about  
fewer number of organisms/ this shows its importance/ that in systematics and  
biology we can provide answer/ as an investigation tool/ em/ I mean there has  
not been a real investigation/ cause it seems that/ em/ we must see a common  
ground among these biologists/ [(reads S12 in RS mode)]/ 05/ it says that  
experimental biologists want to use the mechanism of this potential area/ em/  
and are engaged in/ um/ 03/ on a mechanical basis/ and this aspect of/ em/ as  
the heart of/ em/ the subject that a model of phylogeny/ I don't know this  
word/ and homology/ S13/ it understands the relation and its history/ they can  
provide a necessary model based on sensible necessities as/ 03/ limiting other  
organisms/ em/ it wants to say that in systematics fewer investigations are  
done/ and / 03/ this is an important thing/ and this is an important research tool  
that must receive better attention to be used as a leading model in both  
laboratory and research works/ [(reads the whole third paragraph in RS  
mode)]/ 055/ it says that last year we asked a number of people to take part in  
a symposium which was oriented towards finding a relation between  
systematics and its interference with research works in model organisms/ or to  
find what a suitable model organization is/ S15/ a set of organisms were  
selected to be used as phylogenic/ they made arrangements/ and contacted  
some of the colleagues who were in contact with these two groups of



researchers/ S16/ eight organisms were discussed and six papers/ em / were used in this section/ this 'systematic biology' is the result of such an effort/ S17/ in these papers we asked each writer to discuss a series of subjects on a single organisms/ S18/ to see what sort of conceptualization each writer had about each organism/ and/ em/ their relation/ S19/ why these organisms should be used as model organisms in laboratory works/ S20/ and how we can make them in details/ I mean the organisms data for systematics investigations/ and how we can/ 03/ use such organisms as a comparative guide in labs/ [(reads paragraph four in RS mode)]/ 033/ the next paragraph says that various papers were used about the ideas which were more or less deep/ relating to the thing known as an organism/ and based on an individual systematics/ S22/ in most cases/ em/ 05/ I don't know this word 'lagged'/ which was put behind/ for some species/ it says that phylogeny/ I mean/ this 'rudimentary'/ it is not known to me/ that/ 04/ em/ there was not a good comparable study at that time/ S23/ for/ em/ 04/ vertebrates were identified better/ S24/ in most cases which it is a necessary intervention among all research groups/ a combination is lost which must be added to it/ / [(reads paragraph five from sentence 25 onward in RS mode)]/ 015/ it says that in the rest of the paper we have tried to summarize our ideas about why systematics and laboratory biologists can help each other/ 03/ for a common pattern and a mechanism in biology/ S26/ 03/ em/ we hope that it can partially help the science community in systematics/

and could be used for every model organism such as wheat and 'zebrafish'/ that is a kind of fish which is being investigated/ or 'homo'/ which I don't know what it means/ it can provide an invaluable thing within the mechanisms/ o3/ to create a revolutionary mechanism which can drive it towards variation/ 'diversification'/ and 'cladogenesis'/ which means a sort of variation/ S27/ that this aspect can be a real solution for solving some of doubts about systematics and provide a direct line for laboratory biologists/ that/ em/ it can greatly benefit both groups/ I think I'd better explain the text to you as I read it/ [(reads paragraph six as he concurrently paraphrases the sentences one by one)]/ S28/ the discussion is about choosing model organisms to be used as something essential/ S29/ and not only we/ o3/ we have neither time nor research resources and every species/ em/ I mean detailed/ and / we must spend all this to get answers for the questions/ S30/ it says that if the aim in most works in biology is to find a mechanism/ to understand how/ organisms/ em/ can often be used as a research tool/ S31/ the point which must be understood is that we understand a number of good organisms that/ o3/ bring in good results for the field of biology/ [(reads paragraph seven as he concurrently paraphrases the sentences one by one)]/ S32/ how all organisms are selected to be used as model system/ S33/ some may be chosen initially cause they are both available and variable/ S34/ here it is talking about artificial selection/ em/ in 'pigeon'/ which means pigeon/ doesn't it?→/ [(ya)]/



it was a good model cause/ 03/ em/ em/ beautiful pigeons in England/ em/ 03/ and their 'strain'/ it means population/ it is defining genetic results/ that can occur naturally/ their variations/ we can find 'drosophila'/ which can be collected everywhere/ S36/ most plant models/ there are plenty of cereals/ or weeds/ em/ grass/ isn't it?→/ S37/ mice and 'rat'/ I don't know the difference between mice and 'rat'/ they have always been/ em/ their behavior has been like human/ these habits/ is my translation correct?→/ [(reads paragraph eight as he concurrently paraphrases the sentences one by one)]/ S38/ other models particularly those that are developed recently are selected for/ I don't know this word/ for laboratory work/ 'tractability'<sup>RLV</sup> / em/ S39/ 'arabidopsis'<sup>~~~~~</sup> / it is easy cause it can readily be repeated in the laboratory/ S40/ 'xenopus'/ it is handy/ can be handled easily/ cause its eggs are visible and can be produced a lot/ and it's easy to maintain too/ S41/ 't4' is a bacteriophage and is 'e coli' host that can be remained as/ 05/ a biological molecule/ cause/ 04/ meaning that a special population can grow them and their biology is easy/ and /03/ some cells of an organism/ it is multi-cellular/ and that is / em/ em/ I don't know 'naively'/ what does it mean ?→/ [(simply)]/ which is simply located in / the paragraph says that in each group which animals and for what reason are suitable to be used in laboratory works/ [(reads paragraph nine as he concurrently paraphrases the sentences one by one)]/ S42/ it says although availability and 'tractability' are important/ however finally the ratio for the organisms



depends on their generalizability/ to other organisms/ it says that we must be able to relate it/ that how that can be used as a model organism for other studies/ S43/ it says that most biological words are 'justified'/ em/ 05/ applicable/ em/ agronomic applicability/ medical/ [(reads S44)]/ that depends on the/ development of the model that /how really this model can function as a model and how it can be used/ 03/ I mean/ in comparison with 'context'/ which means context/ S45/ one of our colleagues who is in cellular department explained that in a session in the department/ 03/ em/ working for commonalty/ it explained that/ his name is Gilbert/ S46/ he distinguished that often it comes from a comparative work/ 'comparative' means comparable ?→/ [(ya)]/ S47/ laboratory models can be compared/ em / among 'kingdoms'/ does it mean kings ?→/ [(classifications)]/ ok/ similar to one aspect of life basis/ S48/ this is obvious that it is a powerful source that we understand from the genetic structure or duties and that we can generally talk about protein and cell biology/ S49/ and that is in a higher level in systematics/ S50/ to make it a common in that level/ 04/ 'synapomorphosis'/ of life that is a kingdom/ this paragraph says that only/ 04/ the previous paragraph explained that for what reasons we selected organisms/ it says that what the ability to produce and their availability and maintenance were/ 03/ it is not the important thing/ there are other things which deal with laboratory organisms that are dependent on them/ one should be used as a general model for others/ I mean how we can use it for other

organisms as a model/ [(reads paragraph ten as he concurrently paraphrases the sentences one by one)]/ S51/ it says that some limitations are obvious and that there are differences among model systems/ S52/ the characteristics that guide them and divide them/ it explains this that some of hereditary levels/ what does 'hierarchical' mean?→/ [(related to classification)]/ S53/ individual characteristics such as nucleic acids/ for encoding genetic information/ em/ in life/ em/ while others have limited them to individual species/ population/ or individuals/ S54/ 05/ I didn't understand this sentence/ 010/ S55/ therefore frog/ 'clawed'/ frog/ probably this is a special name for frogs/ it says that 'xenopus laevis' has become a model for biological development in vertebrates/ and it studies the structure of/ em/ neural system/ and natural reproduction/ over individuals of an 'amphibian'/ it refers to this group of frogs/ amphibians/ S56/ in a way from phylogenetic and morphological point of view/ 'xenopus' is a modified creature as a member of frog family/ which is a distinct frog from different aspects/ their biology/ S57/ whether this frog is generalizable to be used as a model for all vertebrates/ and whether that is an/ em/ 'anomalous taxon'/ which is not a good example of a common frog/ S58/ the answer depends on the characteristics/ 04/ S59/ neural migration/ 'xenopus' is a system/ a good model/ S60/ or /04/ from biomechanic of feeding point of view it is an indefinite creature/ few amphibians/ frogs can be used as a minor model/ the main idea of the paragraph is that it shows an example of the limitation which exists for the



models/ a little explanation about a particular frog/ that whether this frog can be used as a general model for all other frogs/ then it says that we can pin little hope in this/ it can be used as a model for a small number of frogs/ on the whole it shows an example of the limitations which we are facing in choosing a model/ [(reads paragraph eleven as he concurrently paraphrases the sentences one by one)]/ S61/ it talks about the power of model organisms/ 03/ therefore it talks a lot about details/ there are special 'data' that are collected by a bigger society of the scientists/ S62/ here its 'weakness' is shown when data are compared/ and it is combined with the lack of a good 'phylogenic' framework which guides us to observe those data/ S63/ a comparison of general and systematics biologists/ 03/ they have their own special things/ and they work on data about model organisms/ S64/ however we have not generally used the scientists' lab works/ here the phylogenic power and phylogenic data/ 04/ are used to 'frame'/ 03/ the questions comparatively/ and the problem partly relates to the differences in vocabulary and approach/ S65/ here the differences between/ em/ experiences/ and an analysis of history of biology can be specified/ if the nature of the questions are specified then naturally there is a disagreement/ as a document/ S66/ one who does an experimental job can ask questions and plan a method of experiment/ S67/ meaning that he can repeat the experiments which can provide answers/ em/ 04/ what does 'unambiguous' mean?→/ [(apparent)]/ that can provide clear answers/ S68/ however/ em/ analysis of



patterns/ 03/ S69/ 03/ the experiments were 'cladogenetic'/ events that happened in the past and which did not replicate/ S70/ there is a struggle which must have been happened/ the results of such studies/ are more likely/ the omission of this 'possibility'/ meaning that the facilities that help to define and clarify an answer/ [(reads S71 in RA mode)]/ 06/ I didn't understand the sentence/ S72/ the reason for this differences is that experimental works done by 'phylogeneticists'/ and didn't intend to understand/ em/ each of these 'disciplines'/ in what way/ 03/ and a deep analysis of the literature/ here cause you told me to explain everything that comes into my mind/ sometimes it comes to my mind whether I am explaining well or not/ whether I understand or not/ and that what you think about me/ about what I say/ cause you have certainly already read the text and I have this idea constantly in my mind how well I explain to you what I am reading/ [(reads paragraph twelve as he concurrently paraphrases the sentences one by one)]/ S73/ and what are the most important ways / em/ that laboratory and phylogenetic research should make relationship with/ S74/ we can link two important interventions between these two research programs/ S75/ the first is the use of 'extensive data'/ where we can understand model organisms through their characteristics/ 03/ 'evaluation' means judgment/ doesn't it ?→/ S76/ we can define/ and show 'cladogenetic' events/ and find similar phenotypes which explain the details of molecule and cells in an organism/ S77/ therefore it makes it possible to explain the characteristics/ the characteristics of 'transformation'/ in a species/ 02/

mechanical level/ [(reads S78)]/ some of the articles in this symposium/ 02/ have presented special examples about gene and gene systems/ which are of potential interest/ S79/ other examples are published elsewhere/ S80/ a set of flower genes are defined/ specially those which are cloned/ 'clone' means to separate/ this is an expression in genetic/ from 'arabidopsis'/ S81/ what does 'putative' mean ?→/ [(accepted)]/ em/ 04/ I don't know 'orthologue' too/ em/ a similar effect is defined in 'snapdragon'/ em/ and also in maize/ S82/ a vast distribution of these genes is suggested to have an effect in flower organ in 'angiosperms'/ these can provide a new instrument/ em/ that lead us to the origin of 'angiosperms'/from 'gymnospremous' ancestors/ I didn't understand this section/ [(reads paragraph thirteen as he concurrently paraphrases the sentences one by one)]/ S83/ the second link which exists between the two disciplines is the use of phylogenic as an assessing tool for model organisms/ S84/ how common are they/ S85/ systematic is based on/ em/ it is related to organisms/ usually when an organism in/ eh/ a kingdoms/ is uncovered/ that is its differences are uncovered/ it becomes necessary/ S86/ em/ 05/ at what level are the differences/ S87/ Taylor explained cases wherein differences between 'drosophila' and 'saccaromycis'/ eh/ 05/ can easily/ 03/ be interpreted as the difference between animals and fungi/ S88/ however the interpretation changes in a particular point in the evaluation/ 02/ evaluation time/ it explains the difference at a kingdoms level/ 05/ its characteristics does not support its

distribution/ S89/ however other studies done with 'ascomycete' and schizosaccharomyces' show that the difference appears in some other places/ leading to yeast/ the specification of this yeast is given here/ S90/ em/ an accurate placement of characteristics explains that a massive change is needed/ em/ an extensive sample/ the main idea of the paragraph is that it explains the second link between the disciplines/ [(reads paragraph fourteen as he concurrently paraphrases the sentences one by one)]/ S91/ the establishment of a/ em/ general model/ it necessarily adjusts this/ it collaborates with systematics and experimentalists/ S92/ this discussion about how 'taxa' and/ how the characteristics should compare with systematics/ while the nature of experimentalists/ 06/ what does 'purview' mean?→/ [(horizon)]/ ok/ that scientists can approach model species/ S93/ it says that a door is open for developing / 03/ for constructing/ 04/ new genetic and development and systematics/ S94/ there is a challenge to separate these three kinds of data as a distinctive system/ therefore differences could still be there/ what does 'mutually' mean?→/ [(jointly)]/ S95/ model species can provide this/ em/ this instrument for constructing this and allow us to develop model systems for evaluating these investigations/

## Retrospection



[(what was the main idea of the text?)]/ the whole text talks about model organisms that exist between laboratory works and experimental works/ and that how we can select from among plants and animals some groups as models for lab investigations and that what characteristics such models must have/ how these models should relate to each other/ [(did you translate word by word when reading this text?/ is this your style of reading?)]/ em/ no/ I first tried to understand the whole paragraph/ of course it has its own impact/ when you/ em/ if you want to read word by word/ eh/ you never get the meaning/ [(from paragraph six onward you suddenly decided to read and explain what you got concurrently/ why?)]/ eh/ eh/ one reason for this was that I felt that I could understand/ another reason was that I thought that I didn't have enough time and I believe that it was an important aspect of my reading/ I mean I didn't want to read the sentences analytically/ I read that first and delved into it / cause that is important that you understand the sentence first/ when you read a paragraph and try to read it up to the end then you see that you can understand the text better cause the paragraphs are all related to each other than when you reread them and explain them/ but I had problems with two paragraphs/ [(do you ever reread a sentence that you don't understand or you have problems with?)]/ ya/ [(when do you usually do this?)]/ at the same time/ I mean when I feel that I don't understand it I return back to the sentence and reread it/ but as for those parts that I said I had problems I had already reread

them and tried to get them which alas I didn't/ [(so you had reread the problematic sentences/ didn't you?)]/ yes/ I mean I tried to understand them quickly/ [(thank you very much for your participation in this interview)]/

### Transcription of the think aloud data revealed by S18

#### Text 3

[(reads S1 to S8 in RA mode)]/ 03/ I didn't have any problem so far/ it has talked about some groups/ 03/ it has discussed some plants/ [(reads S9 in RA mode)]/ I don't know 'explored'/ [(reads S11 to S12 in RA mode)]/ 'heart'/ 03/ 'a host of other issues that lie at the heart of controversies in character independence, models of phylogeny reconstruction, and homology'/ 'reconstruction'/ I don't know 'reconstruction'/ I think it means transfer/ cause it has been discussed from the view point of 'homology'/ [(reads S13 in RA mode)]/ 'array'↗/ a narrow passage of what↗?/ of organism/ what is array?→/ it says that/ um/ 03/ it is a mass/ from a narrow passage of/ um/ alive organism/ 04/ this is my guess/ [(rereads S13 in RA mode)]/ [(reads S14 in RA mode)]/ S15/ 'we chose a set of organisms that spans a broad phylogenetic and biological spectrum and contacted colleagues'/ 'colleagues'↗/ 04/ 'contacted colleagues who are in touch with both groups of researchers'/ [(reads S16 to S20 in RA mode)]/ no problem so far/ [(reads S21 in RA mode)]/ S22/ in most cases, the

systematics has lagged far behind the bench work for several species'/ here it wants to discuss a series of research done/ related to different varieties/ 'for example arabidopsis'/ this is a variety/ 'the phylogeny is so rudimentary that no clear direction for comparative studies can be provided at this time'/ S23/ 'vertebrates'↗/ 'vertebrates'↘/ .....MT...../ 'the physio'/ 'phylogeny'/ 03/ 'is so rudimentary that no clear direction for comparative studies can be provided at this time'/ S24/ 'In all cases, the need for broad interactions among research groups is a missing ingredient that should be added'/ this text that you have chosen is/ some parts of it/ although I read the text/ but those sections which need to be reviewed are a bit difficult/ firstly these varieties such as 'fungus'/ these may cause problems/ I haven't heard them/ / [(reads S25 in RA mode)]/ S26/ 'in so doing our hope is that we may at least partially'/ 'partially'↗/ 'partially'/ 'partially'/ 'convince'/ 'convince'↗/ in many of the cases we hope that at least to do what ↗?/ in a special manner/ um/ 03/ 'the scientific community that the systematics of any model organism be it wheat zebrafish or homo can provide unique insights into the evolutionary mechanisms that drive diversification and cladogenesis'/ 'cladogenesis'/ 'cladogenesis'/ aha/ [(reads S27 in RA manner)]/ it is talking about the two groups/ [(reads S28 to S30 in RA mode)]/ 'if the goal'/ [(rereads S30 in RA mode)]/ [(reads S31 in RA mode)]/ I didn't understand this section/ 'the point is to understand a few organisms very well and apply those results to an appropriate sector of the



biological world'/ [(reads S32 to S33 in RA mode)]/ S34/ 'darwin began the origin of species with a discussion of artificial selection in pigeons'/ 'pigeons'/ ' a good model because there are plenty of pigeons'/ 'pigeons'/ what does 'pigeons' mean?→/ [(pigeons)]/ aha pigeons/ [(reads S35 to S40 in RA manner)]/ it is discussing some plants/ a series of plants/ it explains their characteristics/ for example some plants/ it is talking about their seeds and/ 04/ or for example some animals such as mouse/ but here it is talking about 'rat'/ 03/ or about seeds/ S41: 't4 bacteriophage and its host e coli'/ e refers to its variety/ 'e coli remain important for molecular biology because vast populations can be easily grown and screened and their biology was naively, as it now appears thought to be simpler than that of multicellular organisms'/ it is comparing multicellular organisms/ 'simply' means easier/ meaning it is easier to deal with e coli than multicellular organisms/ [(reads S42 in RA mode)]/ 'rational'/ 'rational'/ 'rational'/ 'for using model organisms depends on the ability to generalize to other organisms'/ [(reads S43 to S44 in RA mode)]/ S45/ 'colleague'/ 'in a department of cellular and developmental biology described the mission of his department as searching for commonalties'/ [(reads S46 to S51 in RA mode)]/

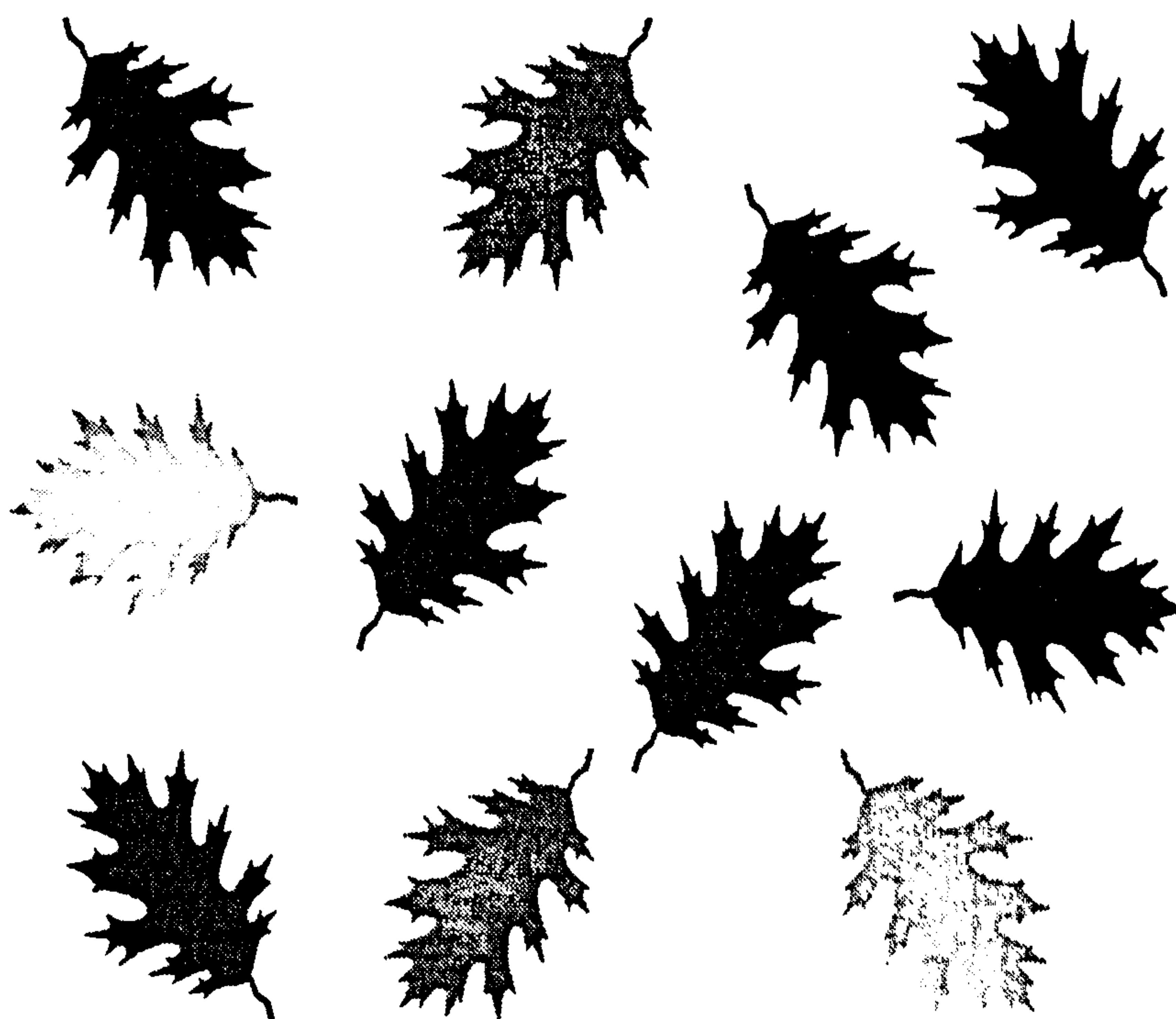
## Retrospection

[(you apparently paused on somewhere in S12/ what was the problem?)]/ 04/ aha/ for example this 'phylogeny'/ I haven't heard it before/ that was probably

the cause/ [(you also paused on S23/ why?)]/ I didn't know what 'notably' means/ I didn't get it/ I can only guess that it may mean ability/ something like that/ [(the same pause occurred on 'research tool' in you reading of S30)]/ it is about research tools/ I didn't have any problem here/ [(what about S50)]/ I had a wee problem with 'synapomorphies'/ in spite of this I got the whole sentence/ [(what was the problem with S56?)]/ 04/ nothing really/ [(what about S64?)]/ 'moreover the laboratory-based scientists have generally not exploited'/ it wants to say that/ um/ it has discussed/ laboratory works/ [(reads S63 to S64)]/ it has compared questions/ um/ nothing really important/ [(what about S66?)]/ 05/ ok/ here for example it asks questions about that/ um/ [(was your pause related to the fact that the researcher wants to ask questions?)]/ there was a question which was asked by the researcher/ [(I mean was the question important to you that caused you to pause?)]/ it is important to see that a researcher can design a model based on the questions he has in his mind/ [(you paused also on S70)]/ [(what was the main idea of the text?)]/ this talks about genetic works which/ 04/ have been subject of investigation/ 05/ it has worked on areas which have not been worked so far but are subject of investigation/ or some plants and organisms varieties such as maize and mice/ [(thank you very much for your participation in this study)]/

## Appendix D

### Sample TOEFL Reading Proficiency Test Used In The Study





Practice Test II, Section 3

Section 3

Reading Comprehension and Vocabulary

Time – 45 minutes

There are two types of questions in this section, with special directions for each type.

Directions: In questions 1–30 each sentence has a word or phrase underlined. Below each sentence are four other words or phrases. You are to choose the one word or phrase which would best keep the meaning of the original sentence if it were substituted for the underlined word. Look at the example.

Example.

Sample Answer

The demonstrators hurled imprecations at the officials.

(A) (B) (C) (D)

- (A) projectiles
- (B) insults
- (C) garbage
- (D) compliments

The best answer is (B), because the sentence "The demonstrators hurled insults at the officials" is closest in meaning to the original sentence, "The demonstrators hurled imprecations at the officials." Therefore, you should mark answer (B).

As soon as you understand the directions, begin work on the problems.

1 The presidency of the United States is often depicted as the world's most strenuous job.

- (A) imagined
- (B) described
- (C) explained
- (D) experienced

2 With costs threatening to get out of hand, a ceiling was placed on expenditures in all departments.

- (A) minimum limit
- (B) cover
- (C) maximum limit
- (D) roof

3 Recently research has focused on a new approach.

- (A) illuminated
- (B) discovered
- (C) looked for
- (D) concentrated on

- 4 The results of the test were quite unambiguous.
- (A) clear  
(B) doubtful  
(C) surprising  
(D) illegal
- 5 Abraham Lincoln was often described by his contemporaries as being an exemplary citizen.
- (A) a typical  
(B) an imitative  
(C) a model  
(D) a presidential
- 6 The original resolution calling for a declaration of independence was bitterly debated by the Continental Congress.
- (A) patriotically  
(B) acrimoniously  
(C) thoroughly  
(D) partially
- 7 For all their protestations, they heeded the judge's ruling.
- (A) In spite of  
(B) On behalf of  
(C) Because of  
(D) Without
- 8 Though he embroidered his tales considerably, there was always a grain of truth in Mark Twain's stories.
- (A) lengthened  
(B) embellished  
(C) repeated  
(D) emphasized
- 9 Secrecy was a decisive factor in the success of the D-day landings.
- (A) major  
(B) choice  
(C) significant  
(D) determining
- 10 She was an unlikely candidate for the position.
- (A) unpopular  
(B) risky  
(C) improbable  
(D) unqualified
- 11 The citizens of Japan were dumbfounded by the appearance off their shores of Matthew Perry's ships in 1853.
- (A) deprived  
(B) delighted  
(C) horrified  
(D) astonished
- 12 Often regarded by the public as outgoing and sociable, this performer is actually rather shy and retiring.
- (A) in fact  
(B) presently  
(C) momentarily  
(D) nevertheless
- 13 Davy Crockett was reared in eastern Tennessee.
- (A) born  
(B) well-known  
(C) brought up  
(D) killed
- 14 icy roads and poor visibility are familiar hazards in the midwest.
- (A) chances  
(B) dangers  
(C) conditions  
(D) occurrences
- 15 In 1844, the government refused to purchase Samuel Morse's invention.
- (A) support  
(B) permit  
(C) build  
(D) buy
- 16 Many immigrants were prepared to work hard and in appalling conditions for the sake of their descendants.
- (A) benefit  
(B) health  
(C) property  
(D) enlightenment
- 17 President Truman's distinctive turns of phrase have led to his being frequently quoted by politicians and political writers alike.
- (A) felicitous  
(B) characteristic  
(C) remarkable  
(D) distinguished

## Appendix D

Appendix D

- 18 In the nineteenth century, poor Europeans seeking to make their fortunes turned to America as a matter of course.
- (A) automatically
  - (B) obviously
  - (C) traditionally
  - (D) resignedly
- 19 Wigs were worn for a different effect in the eighteenth century.
- (A) collars
  - (B) jewels
  - (C) cosmetics
  - (D) hairpieces
- 20 Congress wound up its debate on defense appropriations in a blaze of patriotic sentiment.
- (A) concluded
  - (B) carried on
  - (C) initiated
  - (D) interrupted
- 21 The common shearwater is seldom encountered off these rugged coasts.
- (A) often
  - (B) sometimes
  - (C) rarely
  - (D) inevitably
- 22 So engrossed in his efforts would Gaugin become that he barely noticed the passing of time.
- (A) delighted in
  - (B) frustrated by
  - (C) expanded by
  - (D) involved in
- 23 Potential settlers of the new lands to the west were sometimes intimidated by the pioneers' tales.
- (A) encouraged
  - (B) frightened
  - (C) inspired
  - (D) attracted
- 24 Copper-mining companies complain about the lag between investment and return a view with which stock market analysts appear to concur.
- (A) disagree
  - (B) contend
  - (C) agree
  - (D) conspire
- 25 Only recently has more attention been paid in the United States to providing special facilities for gifted children.
- (A) adopted
  - (B) severely handicapped
  - (C) emotionally disturbed
  - (D) especially talented
- 26 Traders from the various European powers vied with one another over the trade routes to the east.
- (A) competed with
  - (B) replaced
  - (C) followed
  - (D) traveled with
- 27 Railroad authorities in various countries have been irritated by government decisions to hive off profit-making parts of their operations.
- (A) encouraged
  - (B) annoyed
  - (C) distracted
  - (D) worried
- 28 Contact with the substance may result in copious weeping.
- (A) itching
  - (B) burning
  - (C) suppurating
  - (D) crying
- 29 The canyon was formed over the course of millennia as the softer rocks were eroded by the action of the elements.
- (A) eaten away
  - (B) chewed up
  - (C) ridden off
  - (D) piled up
- 30 The upheaval caused by the Cabinet resignations made it difficult for the government to function efficiently.
- (A) slow-down
  - (B) resentment
  - (C) disruption
  - (D) uprising



**Directions:** The remaining questions in this section are based on a variety of reading material (single sentences, paragraphs, advertisements, and the like). In questions 31–60, you are to choose the one best answer, (A), (B), (C), or (D), to each question. Then, on your answer sheet, find the number of the problem and mark your answer. Answer all questions following a passage on the basis of what is stated or implied in that passage.

Read the following sample passage.

The term Badlands is often associated with movies because we think of it as the place where the tough, bad guys come from in the westerns. But this area got its name not because of the people from that area, but because of the difficulties and hardships it placed in front of the early American pioneers and hunters. French-Canadian trappers described parts of southwestern South Dakota as “the bad lands to cross.”

Example I.

The Badlands got its name from

- (A) a movie made in that area
- (B) the disreputable people who have come from there
- (C) the drastic problems it created for people trying to pass through the area
- (D) the hard life the first people who settled and farmed there had

The passage says that the area got its name “because of the difficulties and hardships it placed in front of the early American pioneers and hunters” and that it was described as “the bad lands to cross.” Therefore, you should choose answer (C).

Example II.

The people who first used the term “Badlands” came from

- (A) Canada
- (B) South Dakota
- (C) the United States
- (D) Westerns

The passage says that “French-Canadian trappers described parts of southwestern South Dakota as ‘the bad lands to cross.’” Therefore, you should choose (A) as the best completion of the sentence.

As soon as you understand the directions, begin work on the problems.

### Questions 31–35

The eyes of human beings are not sensitive to all light, but only that between wavelengths of 380 and 760 millimicrons. This fact prevents us from being aware that our bodies emit electromagnetic waves. These waves are mostly longer than we are sensitive to, but thermographic techniques can translate them into extraordinary color pictures.

Because they are constantly in motion, atoms generate infrared rays and the warmer the atoms are the more active they become. This results in thermographic pictures revealing different parts of the body in different colors: black and blue for the cold parts, green and yellow for the cool or slightly warm ones, and orange and red for those which are hot.

All this has a health application, for such problems as tumors, arthritis, and cancer are shown up as isolated red areas on the thermographic portraits.

31 According to the article

- (A) the eyes of human beings are not all sensitive to light
- (B) light wavelengths vary between 380 and 760 millimicrons
- (C) some light cannot be seen by the human eye
- (D) some people’s bodies emit electromagnetic waves

32 Atoms generate rays of light

- (A) because they are infrared
- (B) if they are active
- (C) due to their constant motion
- (D) when they become warm

33 The majority of electromagnetic waves emitted by the human body

- (A) are above 760 millimicrons in length
- (B) vary between 380 and 760 millimicrons in length
- (C) translate into thermographic techniques
- (D) are below 380 millimicrons in length

34 Thermographic portraits show the body in different colors

- (A) only if the patient is suffering from tumors or cancer
- (B) according to the activity of atoms in the different parts
- (C) because some parts are black and blue and others orange and red
- (D) when the atoms are active

35 The atoms in tumors or cancerous areas are

- (A) problems
- (B) isolated
- (C) red
- (D) very active

Appendix D

Questions 36-40

One of the greatest problems for those settlers in Nebraska in the last quarter of the previous century was fuel. Little of the state was forested when the first settlers arrived and it is probable that by 1850, only about one-third of the originally forested area remained, down to a mere 1 percent of the state's 77,000 square miles. With wood and coal out of the question, and with fuel needed year-round for cooking, and during the harsh winter months for heating, some solution had to be found.

Somewhat improbably, the buffalo provided the answer. Buffalo chips were found to burn evenly, hotly, and cleanly, with little smoke and, interestingly, no odor. Soon, collecting them became a way of life for the settlers' children who would pick them up on their way to and from school, or take part in competitions designed to counteract their natural reluctance. Even a young man, seeking to impress the girl he wanted to marry, would arrive with a large bag of chips rather than with a box of candy or a bunch of flowers.

36 What is the main topic of this passage?

- (A) The solution to the Nebraskan settlers' fuel problem.
- (B) Life in Nebraska in the late nineteenth century.
- (C) The importance of the American buffalo.
- (D) Deforestation in Nebraska in the late nineteenth century.

37 Which of the following statements is not true according to the passage?

- (A) Nebraska was not a densely-forested state even before the settlers arrived.
- (B) The children enjoyed collecting the buffalo chips.
- (C) The children spent a lot of time collecting the chips.
- (D) Buffalo chips were satisfactory as a fuel.

38 According to the passage, how much of Nebraska was forested when the first settlers arrived?

- (A) About 33 percent
- (B) About 1 percent
- (C) About 66 percent
- (D) About 3 percent

39 The passage implies that buffalo chips were needed

- (A) in greater amounts in summer
- (B) in greater amounts in winter
- (C) only in summer
- (D) only in winter

40 Which of the following does the author not express surprise at?

- (A) The children needed competitions to stimulate them.
- (B) The buffalo chips gave off no smell.
- (C) Buffalo chips were the answer to the settlers' fuel problem.
- (D) Young men took bags of buffalo chips to their girl friends.

Questions 41-45

One of the most extraordinary of the people discussed was Kansas City-born Ted Serios, who was in his mid-forties when introduced to Jule Eisenbud, Professor of Psychiatry at the Denver Medical School, in 1963.

Over the ensuing three years, Eisenbud proved that Serios was endowed with an extraordinary ability to produce recognizable images on film of distant objects by merely staring with intense concentration into a camera. These "thoughtographs", eventually numbering several hundred, involved people, buildings, landscapes, or machines and were produced under carefully controlled conditions in the presence of scores of reputable witnesses, some of whom were hostile. The precautions to eliminate the possibility of fraud included medical examinations, X-rays, and tying Serios up in a strait jacket or stripping him naked.

In spite of the rigorous scrutiny to which Serios' efforts have been subjected, not only has no satisfactory explanation for his pictures been offered, but the tests have excluded all the obvious kinds of electromagnetic radiation which had originally been viewed as offering the most likely explanation.

41 Ted Serios was born in Kansas City in

- (A) 1945
- (B) 1918
- (C) 1948
- (D) 1963

42 In order to produce his pictures on film, Serios needed

- (A) several hundred people
- (B) carefully-controlled conditions
- (C) a number of reputable witnesses
- (D) a camera

43 According to the passage, the medical examinations

- (A) consisted of X-rays
- (B) were to keep Serios from becoming ill
- (C) were part of tests to guarantee scientific validity
- (D) required that Serios be stripped naked

44 The paragraph preceding this one most probably discussed

- (A) a general account of a meeting devoted to people with unusual powers
- (B) previous research done by Jule Eisenbud
- (C) how Ted Serios developed his incredible ability
- (D) Ted Serios' Kansas City childhood



45 It can be inferred from the passage that

- (A) later studies explained exactly how thoughtography works
- (B) Ted Serios has been able to teach several hundred people how to produce pictures using his method
- (C) strenuous efforts were made to see whether Serios was using some kind of trick
- (D) an obvious type of electromagnetism was subsequently shown to have been the method Serios used.

49 An "internal computer" is

- (A) a computer used exclusively by one company for its own problems
- (B) a person's store of knowledge and the ability to process it
- (C) the most up-to-date in-house computer a company can buy
- (D) a computer from the post-war era which is very reliable

50 The passage suggests that the present-day problem with regard to computers is

- (A) challenging
- (B) psychological
- (C) dramatic
- (D) malfunctioning

51 It can be inferred from the passage that the author would disapprove of

- (A) computer science courses in high schools
- (B) businessmen and women who use pocket calculators
- (C) maintenance checks on computers
- (D) companies which depend exclusively on computers for decision-making

## Appendix D

### Questions 46–51

In what now seem like the prehistoric times of computer history, the early post-war era, there was a quite widespread concern that computers would take over the world from man one day. Already today, less than forty years later, as computers are relieving us of more and more of the routine tasks in business and in our personal lives, we are faced with a less dramatic but also less foreseen problem. People tend to be over-trusting of computers and are reluctant to challenge their authority. Indeed, they behave as if they were hardly aware that wrong buttons may be pushed, or that a computer may simply malfunction.

Obviously, there would be no point in investing in a computer if you had to check all its answers, but people should also rely on their own internal computers and check the machine when they have the feeling that something has gone awry. Questioning and routine double checks must continue to be as much a part of good business as they were in pre-computer days. Maybe each computer should come with the following warning: for all the help this computer may provide, it should not be seen as a substitute for fundamental thinking and reasoning skills.

16 What is the main purpose of this passage?

- (A) To look back to the early days of computers.
- (B) To explain what technical problems may occur with computers.
- (C) To discourage unnecessary investment in computers.
- (D) To warn against a mentally lazy attitude towards computers.

17 According to the passage, initial concerns about computers were that they might

- (A) lead us into the post-war era
- (B) be quite widespread
- (C) take control
- (D) take over routine tasks

18 The passage recommends those dealing with computers to

- (A) be reasonably skeptical about them
- (B) check all their answers
- (C) substitute them for basic thinking
- (D) use them for business purposes only

### Questions 52–56

In order to qualify for a single room in a university dormitory, you must be a full-time student who has completed the necessary number of hours to be ranked as an upperclassman. Applicants for such university housing are required to submit completed applications to the Office of Student Housing no later than the second week of the semester preceding the semester for which they are requesting such housing. Students will be notified regarding the status of their application by the sixth week of classes. Private dorm rooms will be assigned to qualified students on a first-come, first-served basis.

52 According to the passage, private dorm rooms are reserved for

- (A) freshmen and sophomores
- (B) juniors and seniors
- (C) office workers
- (D) high-class men

53 According to the passage, students cannot have individual living quarters if they

- (A) do not carry a full load
- (B) are going to graduate soon
- (C) apply too early
- (D) do not want to share a room



54 What kind of student will most probably get one of the rooms referred to in the passage?

- (A) One who applies in the fourth week of classes.
- (B) One who comes to the office and serves on the student council.
- (C) One who notifies the top advisor of his or her interest in private houses.
- (D) One who applies on time.

55 What is the main topic of this announcement?

- (A) Applying to the university.
- (B) Construction jobs available for students.
- (C) Obtaining a one-person college residence.
- (D) Meeting requirements for being a full-time student.

56 Where would this paragraph most likely be seen?

- (A) In a private dormitory room.
- (B) On a university bulletin board.
- (C) In a student's house.
- (D) Outside a new apartment building.

#### Questions 57-60

For each of these questions, choose the answer that is closest in meaning to the original sentence. Note that several of the choices may be factually correct, but you should choose the one that is the closest restatement of the given sentence.

57 The congressman pledged support for all legislation aimed at reducing the tax burden on the elderly.

- (A) The congressman has voted for all the bills to help old people pay their taxes.
- (B) The congressman has won the votes of the elderly by pledging to support their tax legislation.
- (C) The congressman promised to back any bills that would increase old people's ability to pay their taxes.
- (D) The congressman called on his audience to support more laws to lessen the tax burden on old people.

58 Admission requirements are sometimes complicated and differ from college to college.

- (A) Each college is required to have its own unique admission policy.
- (B) It must be admitted that requirements are very difficult for students at every college.
- (C) There are complex differences in requirements for students to be admitted from one college to another.
- (D) Every college has its own policy regarding admission.

59 One of the most important requirements for starting one's own business is adequate capital.

- (A) The primary source of success for a new business is adequate capital.
- (B) One's own business constitutes one of the most important ways of making adequate use of capital.
- (C) Adequate capital is one of the basic necessities for anyone going into business on his own account.
- (D) The one essential need for initiating a business venture is adequate capital.

60 Contrary to popular belief, physical adaptation to living at high altitudes is environmental and not transmitted genetically.

- (A) In spite of the widespread opinion to the contrary, it is environmental rather than inherited influences that help people to adapt to living at great altitudes.
- (B) Most people do not realize the role geneticists play in transmitting high-level environmental policy.
- (C) Although it is not popular to say so, beliefs relating to high-altitude living are environmental and not genetic.
- (D) The fact that physical adaptation to high-altitude living can be transmitted from one generation to the next is contrary to what is generally thought.

DO NOT WORK ON ANY OTHER SECTION OF THE TEST.

IF YOU FINISH IN LESS THAN 45 MINUTES, CHECK YOUR WORK ON SECTION 3 ONLY. AT THE END OF 45 MINUTES STOP WORK AND CLOSE YOUR TEST BOOK.

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