VARIABILITY IN COMPREHENSION: A LOOK AT THE PROFICIENCY LEVEL AND WORKING MEMORY FUNCTIONS AMONG NONNATIVE READERS OF ARABIC

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ABSTRACT

This paper investigates the influence of readers’ linguistic proficiency level and working memory functions on the reading behaviors and processes of readers of Arabic as a foreign language (henceforth RAFL). Two aspects of reading comprehension, speed and accuracy, are examined in light of readers’ word decoding efficiency, recall performances, response times, scores, and readers’ responses to two quantitative tests: a questionnaire and an interview. Twenty-four subjects participated in this study and were divided into two subgroups based on their proficiency level. The proficiency of these subjects was determined based on their academic level and their overall GPA in Arabic. All subjects completed a series of reading passages, in two separate sessions, followed by comprehension questions. Reading and answer time on the reading passages and questions were timed and scored. Data was also collected retrospectively using a questionnaire and an interview. The results suggest that reading comprehension and the ability to select and implement specific reading processes are impacted by the proficiency level of subjects as well as their word decoding skills. A strong correlation between comprehension outcomes and working memory functions was also found. That is, working memory capacity was found to be influential on the reading behaviors of readers especially at the sentence level with better performances reported for readers with larger and more elaborate vocabulary repertoire. Based on these results, some implications and conclusions are discussed for both Arabic reading research and foreign language classroom.
INTRODUCTION

Historically, reading research goes back over 100 years ago, most prominently to the work of Edmund Huey (1968) who described the achievement of reading as “the most remarkable specific performance that civilization has learned in all its history” (p.6). The original Edmund Huey’s laboratory work, however, goes back to 1908 where he examined reading from a perceptual ability perspective using eye-voice span. In this paradigm the lag between eye position and voice while reading aloud was analyzed using a tachistoscope machine. His laboratory work presents one of the earliest and most enduring results obtained using eye-movement paradigm.

From a scientific point of view, comprehending a language is both a problem and a puzzle that requires the piecing together of textual cues and an interaction between lexical, semantic and syntactic processes. For a skilled L2 reader, comprehending language, whether in spoken mode or written mode, may be quite an easy task once the above mentioned processes interact at such an automatic level that does not require much conscious attention on his/her part. However, for a less skilled reader, especially in an L2 context, such task may be arduous since component abilities of reading such as word decoding and comprehension monitoring are competing for attention and memory resources.

Since the establishment of reading as an autonomous module of research with the publication of Kenneth Goodman’s 1967 seminal article “Reading: A psycholinguistic guessing game” a number of theories and frameworks for the study of reading and how readers process printed texts have been developed. The traditional view that all reading is a essentially a bottom-up process whereby readers first recognize letters, then sequences of letters, then words, phrases and sentences and lastly meaning, has been challenged by more recent models of reading such as
the parallel processing model and the construction-integration model (Kintsch, 1988), all of which assume parallel processing rather than sequential processing as was the case in the bottom-up models. However, more recent versions of the bottom-up processing have made significant moves forward to our understanding of how reading operates (e.g., BIA + model of L2 reading). Most of these frameworks attempted to represent reading as a mental process and as such most fall broadly under one the following figurative categories: bottom-up models, top-down model, or hybrid of both (interactive models).

Research into second language acquisition, especially in the context of English, has shown that the ability to select and implement specific reading processes can be impacted by the proficiency level of the reader (e.g. Alderson 1984, Graney and Mokhtari 1993, Mokhtari and Sheorey 2002). The results of these studies considered that successful reading is the corollary of the use of a variety of reading strategies and processes. This conclusion led researchers to inquire possible factors that may influence the use of these reading processes and motivate individual difference in the use of reading processes. Therefore, factors such as proficiency level have often been examined in the ESL context (See Devine 1988), and a large number of studies have provided evidence for a positive relationship between the learners’ linguistics proficiency and his/her learning processes (Eskey 1988, Coper 1984).

While the bulk of the above mentioned research focus mainly on the linguistic proficiency in relation to learning processes in general, fewer studies have focused specifically on this type of relationship in the context of reading. The present study focuses specifically on the influence of the reader’s linguistic proficiency level and memory resources on his/her reading processes. It should be noted, however, that no consensus has been reached so far on whether proficiency level is influential on reading comprehension. This project is an attempt to examine
this type of relationship in the context of Arabic with particular emphasis one word decoding efficiency and working memory functions.

It is within the general cognitive theory of Anderson’s (2007) ACT-R (Adaptive Control of Thought-rational) and Kintsch (2003) Model of Construction-integration that I propose to analyze the reading behaviors and working memory functions of nonnative readers of Arabic. Very few models of reading attempt to explicitly explain the differences between skilled and less skilled readers. The majority of the comprehension models fall short in this area and instead only focus on general reading processes with the assumption that no individual differences are present (i.e., assuming average reading abilities).

My objective in this thesis is to exploit the basic tools available in reading research to see to what extent they can allow us to adequately analyze the aforementioned aspects of reading comprehension among readers of Arabic as a foreign language. Attaining this objective means a significant move forward towards effective teaching of reading in foreign language classrooms.

This thesis is organized into five chapters. Chapter one gives details about the relevant literature on the topic of reading as well as the theoretical framework that will be adopted in this work. Chapter two presents some reading research from both an L1 and an L2 perspective. Therein, I argue that studies on Arabic reading has been concerned mainly with the effects of certain text properties such as vowelization (diacritical marks) and grammatical knowledge with less emphasis on other cognitive aspects of reading such as the working memory functions and constraints. Chapter three gives details about the methodology and procedures adopted in this work. Chapter four provides the results obtained through the quantitative instruments and offers a comparison of the results. Finally, in chapter five, I discuss the results of the present study and discuss some implications for both reading research and instruction.
CHAPTER ONE: PRELIMINARIES

1. Introduction

This chapter presents the preliminaries, which are deemed necessary to the understanding of the whole work. It is divided into four main sections. Section one gives a brief overview of what constitutes reading comprehension and gives background knowledge on some of the models and theories associated with it. Section two introduces some of the reading processes that will be examined in this work and establishes the theoretical framework adopted for the purposes of this study. Section three lays down the tenets of working memory functions, which, together with reading processes, constitute the hallmarks of reading comprehension. Section four, introduces the theoretical framework that will be adopted for the purposes of the current study.

On the basis of the conclusions made by researchers in the context of English as a second language; that successful reading is the result of the use of various reading processes, this study attempts to check the validity of these results in the context of learning Arabic as a second language (henceforth L2). This project aims at assessing readers’ performances on reading tasks and explaining these results in light of the retrospective tests and the theoretical framework adopted herein. The proposed research aims to test for any correlation between proficiency level, working memory and the reading processes of learners of Arabic. The results of this study offer insights on how to improve readability especially for learners of Arabic as a foreign language. But before embarking on such tasks it is important to remind the reader of the research questions set for this study. The research questions that I ask in this work are as follows:

a. Are readers’ recall performances affected by their working memory functions?

Hypothesis 1: If readers of Arabic rely heavily on visuo-spatial awareness and visual attention, word recognition and letter decoding should show heavy demands on working
memory, thus affecting their recall ability?

b. Are readers’ recall performances affected by their proficiency level?

**Hypothesis 2:** If hypothesis 1 above is correct then less skilled readers will show some difficulties recalling text information due the heavy demands on working memory.

c. Is word-decoding efficiency related to readers’ proficiency level?

**Hypothesis 3:** Graphic similarity should cause less difficulty for skilled readers allowing for better word decoding.

d. Are there any correlations between readers’ proficiency level and working memory functions?

**Hypothesis 4:** If more skilled readers by virtue of their higher proficiency level are able to parse information more automatically, we should expect them to have more cognitive (memory) resources available for text comprehension, and should therefore score higher on the reading tasks.

e. What is the average reading speed of learners of Arabic as a foreign language?

**Hypothesis 5:** Graphic similarity will cause less skilled readers to be much slower at decoding, therefore spending more time reading.

In this paper, I use L2 readers subsuming both second and foreign language readers. The focus here will be on two types of readers: those who can read (less skilled/proficient readers) and those can read well (skilled/proficient readers). The two terms, skilled and proficient will be used interchangeably. In addition to the questions outlined above, I ask the following: 1) what is it that readers do to comprehend text in Arabic? 2) What specific skills or set of abilities (are) typical of skilled readers of Arabic? And how do they use them? 3) How can we account for individual difference in the reading processes among proficient and less proficient readers? Can
such differences be explained in terms of working memory resources and proficiency level?

2. Reading Comprehension

2.1. An Overview

Given the complexity of the reading process and the various purposes of reading, there is no one single statement that can accurately capture the process. In its simplest terms, reading may be defined as follows: “Reading is often the process of receiving and interpreting information encoded in language form via the medium of print” (Urquhart & Weir, 1998:22). In this work, I take reading to be the corollary of the use of cognitive and metacognitive processes. In what follows, I discuss the properties of fluent reading as has been established in reading research.

Perhaps the most important trait of fluent reading is efficiency, which is incumbent on many of the properties that I will be discussing below as well. Simply put, efficiency refers to how well reading processes work together in order to yield a seemingly effortless reading experience. A subcomponent of efficiency is speed. That is, to be efficient, reading also has to be a rapid process. In the English language for example, the average reading time among native speakers is approximately 250-300 wpm (Grabe 2009). It is important to note however that this rate is usually characteristic of reading for comprehension and fluctuates depending on the purpose of reading. For example, someone who is reading for memorization (i.e. for a test) may read fewer than 100 wpm while someone who is just skimming may read at a much higher rate. By contrast, the reading times among Arabic readers (even native readers), is significantly much slower due to the graphemic properties of the language and other factors. Recent research in reading acquisition among Arabic learners has shown that reading pace in Arabic is much slower than in other languages, even among native speakers of Arabic (Azzam 1984; Eviatar and
Ibrahim 2004; Abu-Rabia 2001). It appears that readers of Arabic (natives and non-natives alike) are challenged by certain properties of the Arabic language, which cause the reading to be much slower than other languages (Saiegh-Haddad 2003). For native speakers, the effects of diglossia (the existence of more than one variety of Arabic side by side within a single speech community), and the visual properties of orthography may both play a detrimental role in the development of reading skills. As for non-native readers, it appears to be mostly a problem of the visual properties of Arabic. That is, the graphemic and phonemic properties and their relations may force readers to read in certain suboptimal ways.

A third property of fluent reading that follows from the discussion above is linguistic knowledge. The ability to make graphemic-phonemic connections, recognize words, and morphological processes underlying word formation, along with syntactic and semantic knowledge of the language is the hallmark of fluent reading. Despite the fact that background knowledge can help readers comprehend a text and compensate for linguistic knowledge, there are very clear and obvious limitations to background knowledge. When background knowledge is minimal or non-existent the reader will rely more on linguistic knowledge (Perfetti, Landi, & Oakhill, 2005). Another feature of fluent reading that has been given considerable attention in reading research since the work of Flavell (1976) is evaluation. This refers to the ongoing monitoring of comprehension and the employment of metacognitive reading processes and strategies to remedy in deficiencies in the reading process.

This is by no means an exhaustive list of all that characterizes fluent reading, but the aforementioned reading components constitute the fundamental properties of successful reading. It should also be noted that reading should not be equated with comprehension. In what follows, we highlight two types of processes, lower-level and higher-level processes that are under
2.2. Defining Reading Processes

Due to the divergent views on the nature of reading no consensus exists on the definition of reading processes. Among the terms found in the literature is ‘strategy’, which has the implication that such action requires planning and that the end goal is an objective set before hand (Oxford 1990). Strategy is therefore a conscious and intentional action that requires planning. Other terms that have also been identified in the literature include, ability, process and skill, all of which entail different functions and have different implications for reading comprehension. Brown (1987) for instance defines a ‘process’ as a general concept that refers to all activities humans engage in; and defines ‘strategies’ as “specific methods of approaching a problem or task, modes of operation for achieving a particular end” (Brown, 1987: 79). The difference between ‘skill’ and ‘strategy’ is primarily concerned with the degree of consciousness with which a specific task is approached. In other words, skills usually refer to actions that are automatic, whereas strategies refer to actions that are deliberate and which are usually “available for introspection or conscious report” (Paris et al. 1991). In this paper, I will be using the term ‘process’ to encompass any action that readers take to comprehend a text (regardless of intentionality).

3. Typology of Reading Processes

There have many taxonomies of reading comprehension processes, most of which fall under binary categories such as observable/non-observable, conscious/subconscious, direct/indirect, lower-level/higher-level, bottom-up/ top-down, cognitive/metacognitive. Such dichotomies do not necessarily implicate that these reading processes operate independently of
each other. Rather, both categories operate at the same time and often interact with one another at certain reading tasks. This is not to say, however, that reading processes necessarily interact with each other all the time. Due to the limited scope of this paper, I will adopt the lower-level/higher-level taxonomy of processes. The first category, lower-level processes, describes the set of actions made at the local level (e.g. word recognition) while the second category, higher-level processes, is more aimed toward reading comprehension.

3.1. **Lower-level Processes**

Lower-level describes a set of reading processes that operate locally at the text level. For example, recognizing a word and its sub constituents (orthography, phonology, morphological composition, lexical meaning) falls under lower-level processes because it operates directly at the level of print. Other lower-level processes include syntactic parsing and building clause-level meaning from words and small meaning units. Before I go on to describe each of these processes in detail it should be noted that characterizing this type of processes as lower-level is not to say that they are simple or undemanding. In fact, this category of reading processes is the building block of fluent reading. Lower level simply means that these processes operate at a local/textual level early on in the reading process.

Perfetti (2007) had the following to say about word recognition: “in reading, the singular recurring cognitive activity is the identification of words, this follows two other, related observations about reading: Comprehension depends on successful word reading. Skill differences in comprehension can arise from the skill differences in word reading.” (Perfetti, 2007:357).

Two observations follow from this definition. Visual recognition of words relies on orthographic processing of word forms, which include letters, and letter sequences recognition.
There are many competing theories of how visual word shapes are being processed by the reader. In connectionist theories, for instance, orthographic processing is presumed to proceed on a wholesale basis of letter groups (especially ones that are highly consistent) and word groups, rather than on a letter-by-letter basis. This is especially true of high frequency words, which are read as a whole, a phenomenon known as sight-reading. However, it is not clear how less proficient readers might be analyzing words. A second observation concerns the links readers are creating, while reading, between the graphic forms of the words and the phonological information they have stored in their lexicon. This phenomenon is known as phonological processing.

In a similar vein, morphologically complex words may increase recognition and lexical access time. Although morphological processing is presumed to operate independent of phonology, it is part of word recognition and plays a critical role during reading comprehension. Arabic in particular, as a morphologically complex language, demands a high proficiency (deep understanding) in the language and a good knowledge of the affixation system (more on this in the section on characteristics of Arabic). According to Carlisle, (2000) and Berninger & Abbot (2006), practice can facilitate recognition of morphologically complex and less regular lexical items. Thus, knowing key morphological markers, such as those found in Arabic, can serve as cues for syntactic information that are associated with words, as in by isolating base forms through the root and pattern system in Arabic. The average reader in Arabic is said to possess some 12,000 base forms in their mental lexicon, the rest of the vocabulary is mostly derivative.

Another level involved in word recognition is access to the semantic and syntactic information, which become available immediately after word recognition. Through such processes as semantic spreading activation (Coltheart et al., 2001), a reader is able to activate a
set of nodes related to the words just read (e.g. collocates, similar meanings, etc.). This semantic and syntactic information makes it possible for the reader to integrate words and comprehend longer stretches of text. At issue here is how much vocabulary readers know and how much they know about a particular vocabulary item, two issues referred to as vocabulary breadth and vocabulary depth, respectively. For example, a reader with a low vocabulary base may spend quite some time reading a vocabulary item they have not previously encountered, and as a result, lexical activation is not successful simply because the word at question has no lexical entry.

It is worth mentioning at this point that while word recognition may start out as a conscious and deliberate process on the part of a novice reader, through practice, word recognition becomes highly automatized, thus leading to more efficient reading. Automaticity in word recognition has the effect of not only speeding up the process of reading, but also placing less demands on the processing resources of readers. As will become apparent later on in the section on the role of memory in the process of reading, automatic processes are less demanding on working memory and can be carried out at the same time as other processes. Parallel processing is at the heart of connectionist theory. In most cases, automaticity is the outcome of a process of attending, then proceduralizing, then automatizing (Anderson, 2007). Thus, it can be inferred that fast and automatic word recognition is the result of a well-developed and large lexicon.

Additionally, context may have a differential effect on word recognition ability depending on the language in question. For instance, the average native English reader is able to recognize 4-5 words per second. Therefore, such fast speed obviates the need to wait for support from contextual clues. The reason here being that context information takes some time to register, and at such speed it provides little support for word recognition. By contrast, for
languages in which there is a documented difficulty in parsing word information, contextual information may help (Arabic as a case in point). Another case in which contextual cues may provide support for word recognition is when a reader slows down due to word difficulty or unfamiliarity. In conclusion, a heavy reliance on contextual cues is an indicator of a poor reader.

In short, automatic word recognition affords the reader the ability to direct his/her attention at other processes such as building text meaning rather than fixating at words.

Relevant to the last point made on meaning building is the syntactic parsing process (using grammatical information) and semantic proposition. In order to integrate words and build comprehension, other grammatical cuing systems come into play such as tense, articles, word order, and so on (Grabe, 2005; Perfetti, Landi & Oakhill, 2005). Experimental findings of research on sentence processing have consistently shown strong (negative) effects for complex and ambiguous sentence structures (Townsend & Bever 2001). For instance, consider the example “the horse raced past the barn fell”, a classic example of garden path sentence in which a reader’s syntactic parsing (prediction) reaches a dead end causing him/her to reanalyze the entire sentence. In this example, the expectation built up by the reader is led into a different direction because of the word “fell”. The point to be made here (and one which is often overlooked) is that grammatical and syntactic information is continuously involved in reading comprehension. The processes that lead up to syntactic parsing build on clause-level meanings that are in turn based on word information. These “bits of meaning” are known as “semantic propositions” (Fender, 2001; Kintsch, 1998), which are the building blocks of reading comprehension. Strong evidence for the psychological reality of these semantic propositions comes from experimental research findings that texts manipulated in a way that allows for automatic phrase boundaries detection lead to a faster reading rate and better syntactic parsing.
(Jandreau, S. and Bever, T.G., 1992). This research provided the first systematic evidence that poor to average readers lack certain perceptual strategies to group and detect phrase boundaries. That is, identifying word sequence boundaries is just as important as word segmentation and is crucial for the establishment of information parsing and meaning building. In sum, semantic propositions can be viewed as networks of meanings that help activate text information. Having discussed the operations of lower-level processes, I now turn to discuss the higher-level processes involved in reading comprehension.

3.2. Higher-level Processes

The question of how comprehension emerges from reading is one that most discourse comprehension researchers grappled with. As such, the actions and processes that define higher-level processes are not as uniformly and clearly defined as lower-level processes (Grabe 2009). In general, higher-level processes may be referred to as comprehension processes that a reader employs at both a conscious and a subconscious level. At a conscious level, a reader may be required to direct attentional resources to the reading process, as when difficulties arise or when a specific goal requires attention to certain aspects of the text. For instance, a text read with the purpose of answering comprehension questions (e.g. test) may require conscious attention to linkages between ideas in the text. Similarly, an informational text that contains a considerable amount of dates and facts may require even more attentional resources to be allocated to comprehension and information retention. Therefore, a working memory hampered at the word recognition stage may not be able to allocate enough resources to attend to text meaning and information. At a subconscious level, many aspects of higher-level processes can be carried out automatically unless, as stated above, difficulty arises or specific aims are brought into the reading process (e.g. unfamiliar vocabulary or topic, grammatically complex and embedded
sentences). Some examples of higher-level processes include building a text model of comprehension, integration of background knowledge to build a situation model of the text, making inferences about missing information and “in-between-line” reading, monitoring comprehension, executive control functioning (see section on working memory role).

4. Models of Reading

The early phase of research into reading (past four decades) has been characterized by an overgeneralization that attempted to provide a general understanding of the reading process. As a result, many models of reading have emerged and were stated metaphorically as bottom-up, top-down, and interactive model of reading (Grabe, 2009; Hudson, 2007; Urquhart and Weir, 1998 2014). Kenneth Goodman’s Guessing Game model is a classic example of a top-down model of reading despite the fact that Goodman did not express it as such. As can be deduced from metaphorical terminology used to describe these models, these are attempts to represent reading as a mental activity. The metaphorical labeling of these models reflects certain assumptions about how reading comprehension works. Proponents of the bottom-up model argue that reading proceeds mechanically from the smallest units of text to the largest: letters, words, and sentences in a very linear fashion. Such model is deeply grounded in word recognition parsing and reflects the view that background knowledge of the reader has little relevance to text comprehension.

Top-down models of reading comprehension, on the other hand, are based on the assumption that reading is a process directed by the reader goals and expectations. In this sense, reading places particular importance on readers’ background knowledge, rather than piece by piece mechanical procedure of letter decoding as suggested by the previous model. However, this model is very problematic in the sense that it assumes that all texts are read with the same purpose, i.e. creating expectations and finding text information. In short, top-down models of
reading are heavily invested in the readers’ inferencing ability and background knowledge. And in doing so, it places significant cognitive load on the reader.

Goodman claims that “reading is a psycholinguistic guessing game” that goes through predicting, sampling, confirming, and correcting (Goodman 1967). However, Goodman’s hypothesis is one-sided and draws heavily on reader’s background knowledge. Additionally, there is conclusive evidence that such process cannot operate independently of word recognition. Further, it comes at the cost of productivity since the reader has to spend time and resources to make predictions and then try to confirm them. For instance, Pressley (2006) and Stanovich (2000) have shown that good readers make less use of context than poor readers. Another criticism that can be leveled at Goodman’s psycholinguistic guessing model is the fact that it assumes that readers process texts in the same way across linguistic proficiency levels and languages, and that L1 and L2 reading is the same.

Because both models above tend to be rather extreme in their view of what characterizes good reading comprehension, there seems to be a need for a middle ground that can bridge the two views. Interactive models of reading came as a compromise between the top-down and bottom-up view of reading. Therefore, word recognition is considered to be a necessary condition for fast and efficient reading just as background knowledge while also asserting the primacy of inferencing to text comprehension. However, it appears that the interactive model is self-contradictory for two reasons. First, this is not how memory works. There is evidence that when a reader stops to analyze words on a letter-by-letter basis much of the working memory space is been consumed leaving little for inferencing, recalling information from long-term memory (background knowledge) and overall comprehension. Secondly, good reading is characterized by automatic word recognition that does not proceed piece-by-piece mental
translation of text information. Concepts such as sight word and rauding (the combination of reading and listening “auding”) are a good example of automaticity in reading. Therefore, some of the key aspects of bottom-up processes (such as word recognition and letter decoding) may not be fully compatible with the top-down models. In order for this model to be workable, some revisions must be made.

In what follows, I review specific examples of reading models. It is worth mentioning at this point that the models described below do not specifically address any differences that might exist between L1 and L2 reading. There is an assumption that the processes underlying reading are transferable crosslinguistically. The models that will be discussed below fall under the rubric of one or more of the three frameworks outlined above.

5. Specific Models of Reading

5.1. Interactive Compensatory Model

One specific model that has received special treatment and has prominence in the literature is the Interactive Compensatory Model (henceforth ICM) (Stanovich 2000). This model proposes that efficient reading involves automatic processing of text information. At the same time, it acknowledges that certain compensatory strategies may be needed to allow for fluent reading. For instance, when comprehension is degraded (as when encountering unfamiliar words), the reader may interactively compensate by incorporating information from context. However, there is an underlying assumption here that skilled readers are less dependent on context.

5.2. Word Recognition Model

Recent iterations of Seidenberg and McClelland (1989) Word Recognition Model (henceforth WRM), are widely recognized in the literature on reading. Although not models of reading
comprehension in themselves, they offer some interesting findings in processes that underlie the input for efficient reading. What makes the Word Recognition models interesting is that they are based on connectionist theories of information organization in the mental lexicon. Under this framework, information in the brain is thought to be organized and connected by millions of neuron networks with each lexical item being represented by bits of these neurons. The retrieval of a given item is greatly facilitated when lexical items share some networks. As readers sight new words in a text, neurons in the brain reassemble themselves to recognize new words. One key aspect that all word recognition models share is that they are more bottom-up oriented.

5.3. Simple View of reading

Another view of reading that synthesizes both ICM and WRM and has been widely acknowledged in the literature is the Simple View of Reading Model (henceforth SVRM) (Hoover and Gough, 1990). The basic principle underlying this concept is that the ability (often described as skill) to decode script and understand overall text is calculated on a percentage basis to give a measure of reading comprehension. That is, both word decoding and general comprehension are assigned certain percentages, which are then combined to yield a score that would (presumably) accurately measure the degree to which comprehension of text has been achieved. However, how exactly these scores are calculated has not been explicitly discussed in the literature and can potentially be problematic given that a number of other factors are not taken into consideration (e.g. background knowledge, metacognitive awareness, among others) (Kirby and Savage, 2008). Despite its limitations, the SVRM enjoys wide popularity and has the potential to account for individual differences in reading abilities.
5.4. Dual Coding/Route Model

Sadoski and Paivio (2007) proposed a fourth model known as Dual-Coding Theory (henceforth DCT) which, in addition to the basic ideas outlined in the above models, highlights two modes of processing (i.e. verbal and visual) that are linked but separable sub-systems of text representation. Some examples of these verbal and visual inputs include imagery, visual representations, and action responses. As a general theory of cognition, the DC theory attempts to account for two keys aspects that were not directly addressed in the models above, i.e. vocabulary, and memory. Unlike previous models of reading, this theory does not propose abstract mental representations (e.g. schemata, proposition). Instead, in the cognitive architecture of DCT the mental representations are built directly using linguistic (e.g. orthography) and visual input without the need to have recourse to abstract representations of meaning information and text model networks such as semantic propositions and conceptual schemata. As a byproduct of this dual function, a vocabulary instruction that uses a combination of verbal and nonverbal modes is likely to result in a longer lasting effect since information encoding here is taking place via different pathways to the lexicon. The notion of “logogen” is used to refer to information that is coded in such way whereas “imagen” refers to any code that has to do with recognition and memory.

Relevant to Sadoski and Paivio’s Dual Coding model is the discussion of whether readers rely on phonological or lexical “routes” to the lexicon (Henderson, 1984). The argument here stems from the differential reading speed reported when encoding regular vs. irregular words. Recall that the word recognition model proposed at the beginning of this section does not specify how such differences could emerge. Rather, word recognition traditionally assumed a rule-based decoding that proceeds from graphemes to phonemes. The Dual route model recognizes two
pathways to encoding and word recognition: a phonological route that translates letters into sounds and a lexical route which gives direct access to words in the lexicon. Such distinction explains the differential speeds of access reported among readers of English in the case of regular (recognized both phonologically and lexically) vs. irregular words (recognized lexically). Pseudowords on the other hand would be recognized only through phonology, as they are rule-based. In Arabic reading research, the dual route model is at the center of the Orthographic Depth Hypothesis (Frost et al, 1987), which distinguishes between two types of orthographies: a shallow orthography (one with simple one-to-one correspondences between graphemes and phonemes) and a deep orthography (one that lacks such consistency between graphemes and phonemes). Arabic offers a unique laboratory for such model, as it can be both shallow and deep (see the section on Reading Research).

5.5. Construction Integration Model

The CI was first proposed by Kintsch in 1988 and later developed in 1998 by the same researcher. It is considered to be one of the earliest and better-formulated models of reading comprehension in that it captures multiple cognitive processes of reading and relies on discourse processing. As the name implies, the CI model refers to two sequential processes: a construction phase whereby information from the text gets activated and an integration phase where this activation spreads across a network until it settles. Although I say relevant knowledge here, the information that this model assumes to be activated assumes that the bottom-up (or rather the top-down) processing does not constrain which knowledge gets activated initially, a procedure that Kintsch labels as dumb activation. The construction phase posits four possible ways of sources of input: 1) the current input (sentence or proposition), 2) previous input (carryover from prior sentences or propositions), 3) related knowledge, 4) reinstatements (from previous text).
Further, there are three principal levels of representations associated with this model: 1) surface structure (words and syntactic constituents), 2) the propositional textbase, and 3) the situation model (includes inferences which provide the basis for establishing relationships between propositions).

Admittedly, the surface structure has not been given much attention in Kintsch framework because it is assumed to have little bearing on comprehension. In fact, this is one area where the model falls short. Kintsch CI model is based on a constraint and satisfaction principle, which supposes that spreading activation continues until there is little change in node activation at which stage the network settles. Another principle at work here is that while spreading activation proceeds from the highly activated concepts to the least relevant ones, it is necessarily constrained by limitations in the working memory of readers. Therefore the resulting patterns from this activation leave only ideas and concepts that are highly connected (e.g. more semantically related). To date, Kintsch model remains one of the most well-formulated and complete cognitive frameworks for the study of reading.

The short survey of research on reading provided above clearly shows that the literature on the topic is divided into two components: decoding (word recognition) and comprehension. As Gough, Hoover and Peterson put it: “Both skills are necessary; [but] neither is sufficient” (1996, p. 3). One might also add that since all of the models discussed above attempt to showcase reading as a mental representation, they do not consider other important factors that shape how readers approach text (e.g. proficiency level). While significant advances have been made in the context of L1 reading little has been said about L2 reading, perhaps due to a general implication that skills from L1 reading are transferable to L2 contexts. More research is needed to empirically validate such transferability claims.
6. Role of Working Memory

Central to reading comprehension is the way in which the various processes and skills outlined above interact with one another. Memory is presumed to play an important role in orchestrating both lower-level and higher-level processes. As noted above, reading and monitoring comprehension requires that information be retrieved quickly and accurately. In addition to accessing meanings of words from semantic memory, a reader is also required to integrate the meanings of these words into sentences and to relate previously read information with new information. This ability relies on what is termed working memory or short-term memory (Baddeley, 2000). The concept of working memory was first put forward by Miller, Galanter and Pribram (1960), and was later developed by Baddeley and colleagues as a unitary system encompassing phonological unit, visuo-spatial unit, and a central executive.

Although the two terms, working memory and short-term memory, have come to be used interchangeably in the literature on reading, an important distinction must be made. While short-term memory (STM) affords the possibility to retain small bits of information for immediate processing, working memory (WM) provides a “workspace” that also manipulates the temporarily stored information “so as to allow people to perform such complex activities as reasoning, learning, and comprehension” (Baddeley, 2015). Therefore, the STM system is subsumed and operates under the WM system. In this paper, I will be using WM to mean both simple retention of information and manipulation of such information (tested immediately or after a short delay).

However, simply holding information in the short-term store for long enough does not guarantee learning (see Craik and Lockhart, 1972). Therefore, the way in which material is processed is more important than simple storage. Craik and Lockhart (1972) proposed a theory
that posits different levels of processing. The central premise of this theory is that information that is more deeply processed has the potential to be better remembered. Based on this multi-level of processing, Additionally, Baddeley and Hitch (1974) proposed a three-component model of verbal STM. The first component of the model, the phonological loop, is assumed to be specialized for holding sequences of acoustic or speech-based items. This, in turn, has two subsystem; a short-term store responsible for holding items in memory, and an articulatory rehearsal process that readers/hearers utilize in order to keep information active and refreshed (as in saying items to oneself). Any speech-like information is presumed to be stored through the phonological loop. The second component, the visuo-spatial sketchpad, is responsible for holding visual and/or spatially encoded information. The third component, the central executive, serves as a controller for both the phonological loop and the visuo-spatial sketchpad.

More recently, Baddeley (2000) added a fourth component, the Episodic Buffer to account for how such information processed at the level of short-term memory is transferred to and interacts with long-term memory (LTM). The model now features the following components (Figure 1):
Figure 1: Baddeley’s (2000) revised version of the multi-components of Working Memory.

So, why does all this matter? It is important because such model of WM memory explains not only what textual information is stored during the reading process, but also how such information is being manipulated. Factors such as word length, letter transpositions, word order (problems of serial order), phonemic and graphemic similarities, recency effects, primacy effects, all affect how a reader manages and monitors information and textual clues. The central executive in particular, as an attentional resource regulator, is implicated very closely with reading comprehension.

7. Theoretical framework

This present work is couched within the cognitive theory of learning along with John Anderson’s (2007, 2013) ACT-R (Adaptive Control of Thought-Rational) which assumes that learning follows a general path from cognitive (or declarative) learning to associative (or procedural) to autonomous learning (developing automaticity in calling up and using knowledge resources and information). Together with a modified version of Kintsch’s Construction-
Integration model this framework provides an adequate analysis of the influence of working memory and proficiency level on the reading processes of L2 readers. As will become apparent from the discussions to follow and the results presented by this paper, this is particularly true in the case of reading. It is therefore an incremental process where practice plays a central role in converting cognitive knowledge to automatic parsing of such knowledge to the point of becoming an effortless and rarely a conscious process. Vocabulary depth is at the heart of the analysis that I provide under this theoretical framework.

8. Conclusion

In this chapter I reviewed some aspects of reading comprehension as well as the theoretical underpinnings of some of the models associated with it. I have shown that due to the complex nature of reading it is necessarily difficult to capture all its components under a single model. Each of the models outlined above offers insights into some aspects of the cognitive basis of reading. Based on the review I offered in this chapter, I presented a specific theoretical framework for the present study that takes as its basis Anderson’s (2007) general cognitive theory of learning ACT-R along with a modified version of Kintsch Construction-Integration model that, in addition to its computational strength, takes word recognition as a fundamental level of text representation. In the next chapter, I turn to describe some of the basic characteristics of the Arabic language and what they entail for non-native readers of Arabic in terms of information decoding and processing. Some reading research will also be reported.
CHAPTER TWO: READING RESEARCH

1. Introduction

In this chapter I discuss the basic properties of Arabic that have a bearing on the processing of Arabic texts especially in the foreign language contexts. Section one gives a brief overview of some of the salient characteristics of the Arabic language while section two review some of the literature on the effect of proficiency level, working memory, and related aspects of Arabic such as orthography and phonology on the reading comprehension.

2. Characteristics of Arabic

Arabic belongs to the Semitic family of languages and is characterized by complex word derivations system. These features have significant influences on word recognition processes and as a result also influence the theories and models that explain reading comprehension. It also has implications for our understanding of the contextual factors and cues (e.g. word characteristics and lexical knowledge) that influence it.

To begin with, there is almost a predictable sound-symbol correspondence between letters and their sounds. The phenomenon referred to as Orthographic Depth Hypothesis (ODH thereof) predicts that languages (e.g. Arabic) that show high transparency and consistency in letter-phoneme correspondence (i.e. shallow) support a smoother word recognition experience by allowing the printed word to be easily recovered using simple phonological computation. However, for languages with deep orthographies such as English, ODH predicts that lack of consistency between spelling and pronunciation is likely to result in differences in the processing of printed words as the reader is likely to use a direct look-up strategy of words without using grapheme speech decoding (Hulme et al 2007). This discussion is especially important when considering the extent of orthographic differences between L1 and L2, as is the case in the
A logical question that follows from this discussion is whether a reader, whose L1 is English, would benefit from the transparency of an L2 orthography that is highly transparent such as Arabic.

Relevant to the discussion, is a study by Koda (1999), which examined the influence of L1 background of Korean and Chinese students on their sensitivity to L2 orthography (in this case English). The background investigated here concerns crosslinguistic effects rather than topic background. The results of the study suggest a strong influence of L1 background on orthographic sensitivity in L2 processing. Although results of other studies might diverge on the extent to which L2 orthographic features influence the processing efficiency of L2 reading, it is important to note that such effects are language-specific.

Other properties of the Arabic language that come into play in reading and which have significant implications for word decoding include vowelization, letter shapes, letter position, placement of dots (e.g., ن – ي – ن – ب) and the morphological (de) composition system. In most modern written and printed Arabic texts no vowel signs are present and the reader has to deduce them from context or prior knowledge; thus, increasing the difficulty of parsing and word recognition, esp. for beginning or less skilled readers. There is evidence that, for native readers of Arabic at least, fully vowelized texts are actually cognitively demanding. Therefore, in this study I opt for unvowelized texts, unless where ambiguity could arise in certain words,

Additionally, certain letters are distinguishable from each other only by a single stroke or dot and the form of a particular letter may differ depending on its position in a word (i.e., Initial, medial and final position). Some of these letters do not connect. Therefore, recognizing these rules is critical for word decoding and recognition. Furthermore, there are certain irregularities that require the reader to bring to the text considerable knowledge of literary Arabic (syntax,
vocabulary and contextual cues) (Abu-Rabia 2006). Another key feature of Arabic is the morphological (de) composition system (the root and pattern). This involves the interleaving of two levels of morphemes - a root comprised of consonants, which convey the semantic meaning, and a word pattern consisting of vowels that carry both phonological and morphosyntactic information.

All of the above features of Arabic script and orthography point to potentially different reading strategies than those employed, say in languages with Roman alphabet. Because directionality and the position of strokes (e.g. bd, pq), in such languages (e.g. English) play a crucial role in word identification it is well established that readers of such languages build a letter recognition system that searches for those features in the language. However, in the case of Arabic, letter sequences and word recognition require a different scanning procedure. Instead, a reader of Arabic is likely to develop a scanning strategy that would consider curls and dots, letter sequences based on connectivity principles and co-occurrence restrictions, presence of three letter root, and so on. Following this line of reasoning it appears that word recognition and letter decoding in Arabic is likely to be more heavily dependent on visuo-spatial awareness and visual attention than is the case in other languages (Share and Levin 1999; Abu-Rabia 2001; Shatil and Share 2003; Ibrahim et al. 2007). It follows from this that reading a text in Arabic is quite demanding due to the graphemic similarities present in the language and as such the reading time is likely to be substantially longer than has been established in Romance and western languages. Both Ibrahim et al (2002) and Eviatar et al. (2004) confirmed that Arabic-Hebrew bilinguals were slow in processing Arabic and Hebrew letters, but with significantly slower processing in the case of Arabic. The added dimensions of proficiency level and working memory function in the present study are hoped to shed some more light on this area.
3. Reading Research

Before reporting some studies, it is worthy to mention that research in this area is characterized by an unevenness in the extent to which reading processes and their relationships to proficiency level and working memory have been addressed in bilingual research. This is partly so because of the added complexity that L2 brings to the problem of reading. A second cautionary note is that the current state of knowledge about reading is largely derived from research on English and other European languages. As a result, some of the findings in reading research in the context of Semitic languages are not always in sync with the findings of reading theory based on English and other European languages.

Furthermore, research into reading falls into two categories. The first type, which can be termed as descriptive, focuses on describing reading processes and the effect of other factors (related to the reader and written discourse) on the reading process. The second type concerns experimental studies that capitalize on the effect of text manipulations and instruction on reading performance. The aim of the present study is grounded within the first type of studies. Therefore, most of the studies that will be reported below are descriptive (does not interfere) in nature. In addition, most of these studies belong to the ESL (or L1). It should also be noted that many of the studies reported below interpret their results from a dual route model perspective.

In 1976, Olshavsky conducted a study on the effect of L1 readers’ proficiency, interest, and writing style on the reading process. The study used a think-aloud protocol and adopted a 2x2x2 design with each independent variable divided into two levels: low and high proficiency, lower and higher interest, and abstract and concrete style. For the purpose of this study, 24 10th grade students with these characteristics were asked to read four short stories and to verbalize their thoughts at each red dot placed after each independent clause. Olshavsky hypothesized that
readers with higher interest, more proficiency and an abstract writing style would use more processes than readers with lower interest, less proficiency and a concrete writing style. It was also found that the three independent variables relatively influence the frequency but not the variety of reading processes. All subjects used the same type of processes, but those with lower interests, less proficiency and a concrete writing style were found to be less strategic (use less).

In a similar study, but this time in an ESL context, Hosenfield (1977) examined the link between successful reading and process type. She divided her subjects into low and high score groups on the basis of their performance on a reading proficiency test. The think-aloud protocol used by Hosenfield revealed interesting results on the relationship between reading performance and reading processes. These results suggest that successful readers (those who scored higher on the test) tended to “keep the meaning of the passage in mind, read in broad phrases, and skip inessential words, guess from context the meaning of unknown words and have a good self concept as a reader” (Hosenfield, 1984: 233). Unsuccessful readers, on the hand, were unable to keep the meaning of sentences as soon as they decoded them. Besides, they read word by word or in short phrases, over rely on the dictionary to solve problems and have a negative attitude about themselves as readers.

Using the same elicitation technique, Block (1986) conducted a study with non-proficient readers who were either native or ESL speakers (Chinese, Vietnamese, and Spanish). These subjects were asked to verbalize their thoughts at each red dot placed after each sentence. Block identified four characteristics of the reading process of her subjects: integrating information, recognizing text structure, using background knowledge, and responding in extensive versus reflexive mode. On the basis of these characteristics, Block distinguishes between successful readers or “integrators” and unsuccessful readers or “non-integrator”. Integrators were able to
perform better because they answered in the extensive mode. In other words, they focused on the text and comprehending the ideas of the writer, and not on relating the text to themselves. Non-integrators were unsuccessful because they relate to the text “affectively and personally, direct attention away from the text and towards themselves, and focus on their thoughts and feelings rather than in the information in the text.” (Block, 1986: 471-472). In addition and as it has been noted before, Block made a distinction between local and general processes. She suggested that, unlike less skilled readers, skilled readers rely more on general processes than on local ones.

Block’s study highlights an important issue about reading comprehension. It suggests that differences in the use of reading processes may exist even between readers of the same level of linguistic proficiency. All her subjects belonged to one level of proficiency. However, she found that there are differences in text processing between subjects. This means that there are other factors other than proficiency level that influence the utilization of reading processes. While this study indicates that comprehension is a reading problem, Block has not answered whether it is also a linguistic problem. The results of Block’s study are not conclusive as the sample was small and does not allow for generalizability. Besides, she does not provide enough explanation for the factors that might have affected the type of processing among her subjects.

Waxman and Padron (1987) tried to investigate the influence of reading performance on the type of processes involved in reading. Eighty-two Hispanic ESL young learners, who belonged to either third, fourth, or fifth grade of a public elementary school, participated in this study. Over a period of four month the subjects took a diagnostic test (The Stanford Test) on reading comprehension twice to examine any possible links between comprehension gains and processes reported. Additionally, the participants were asked to fill in a fourteen-item likert-type questionnaire on the extent to which they used a particular process. The results of this study
suggested that asking questions, checking recall of ideas, imaging, thinking about something else while reading, taking notes, skipping difficult parts were the most frequent processes reported in the questionnaire. It was also found that the processes reported reflect students’ reading performance. This was due to the fact that higher achieving students in the diagnostic test used effective and successful processes.

In a similar vein, Anderson (1991) conducted a study on the influence of individual differences on the reading process. This study was conducted in a southwestern university in the United States. Twenty-eight Spanish adult second language learners participated in this study. For the purpose of this study, subjects were engaged in two reading tasks: a standardized reading comprehension test and an academic text. A placement test grouped the participants into different proficiency levels ranging from beginners to advanced levels. Furthermore, subjects were asked to answer comprehension questions on two types of measures: the Descriptive Test of Language Skills and the Textbook Reading Profile. In parallel, subjects reported the processes they used in performing the two tasks using the think-aloud procedure. The results show that successful performance could not be attributed to any one single set of reading processes. It was suggested that successful reading was due to the way subjects used these processes, rather than the type of processes themselves. Therefore, both high and low proficient readers may use the same processes but with differing results. Low scoring subjects used these processes less effectively than high scoring readers. This means that those who knew when and how to use a particular process were more successful that those who did not. This study then stresses the idea that reading comprehension is a reading problem. It rejects the hypothesis that the level of proficiency affects the type of processes utilized by ESL readers. The level of proficiency herein is influential on the “how” of the reading process.
This time in an L2 context and using narrative texts, Leeser (2007) examined the effects of topic and working memory on reading comprehension outcomes among 94 adult university level learners of Spanish. The results of the study showed a clear effect of knowing the relevant topic knowledge on L2 reading comprehension. Further, Leeser (2007) noted that background knowledge along with working memory also influenced readers’ ability to form connections between form and meaning. Abu-Rabia (2003) reported similar results concerning the processing and storage functions of working memory. In this study, Hebrew and Russian speaking learners of English were tested through a series of reading comprehension passages. The study found significant correlations between having large working memory store and the reading/writing proficiency in English.

In an Arabic as a foreign language context, Khaldieh (2001) reported that knowledge of vocabulary, but not knowledge Arabic i’raab (declension) system, had a significant impact on readers performance on reading comprehension tasks. The subjects in this study were divided into two subgroups; a proficient and a less proficient group, and were asked to read an expository text and write, in their first language, information from the text. This recall protocol was aimed at assessing subjects overall reading comprehension and was immediately followed by a vocabulary task and an i’raab task. The results clearly showed that reading comprehension in this study operated independent of i’raab knowledge, while lexical knowledge played a significant role in comprehension. It should be noted here that while studies on Arabic found no correlation between knowledge of i’raab and reading proficiency, in other languages such French it has been reported that deficiency in syntactic information embedded in words affects reading comprehension (Barnett 1986). A possible explanation for such differences may involve the extent to which such syntactic information changes word shapes and their semantic properties.
In another study by Abu-Leil et al (2014), it was found that the development of reading comprehension ability is dependent on decoding efficiency. The study investigated the effect of vowel marks on the accuracy and speed of reading. The findings of the study point to two interesting, yet paradoxical results. On the one hand, it showed that vowels appear to help less proficient readers by providing more phonological information. On the other hand, vowels appear to hinder and distract more proficient readers, as they were unable to tune them out during the process of reading. The results are consistent with those of Parkinson (1991) who found that advanced native speakers of Arabic do no attend to vowelization or i’raab markers (case endings).

The bulk of research on reading in Arabic has been carried out under the framework of orthographic depth hypothesis (ODH (Feldman and Turvey 1983; Frost et al. 1987; Katz and Frost, 1992). The general aim of these studies has been to explore the differences in the reading processes of Arabic as compared to other European and western languages. As noted earlier, the ODH predicts that differences in grapheme-to-phoneme correspondence (transparency) mirror differences in how readers approach printed texts, with shallow (transparent) orthographies using more phonological decoding route while deep (or less transparent) orthographies calling upon a more direct (lexical) route\(^1\).

Arabic, much like Hebrew, represents a unique environment for the use of ODH since it can be both shallow or deep depending on whether the vowel marks are present or not. For instance, in one mode of orthography fully vowelized Arabic text would be highly shallow since it will draw heavily on phonology, whereas unvowelized Arabic text will be considered very deep because of the lack of phonological information; thus, the need for a more direct (lexical) route.

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\(^1\) See also the dual route model.
word recognition.

However, by separating phonology and orthography, the ODH makes for a rather narrow framework for the study of the reading process in Arabic. In fact, more and more researchers are calling for a more integrated (connectionist) framework to allow for a more flexible word recognition system (Plaut, 2005; Rohde and Plaut 2003) in which words are computed (in a network) rather than accessed from a lexicon.

4. Conclusion

In this chapter, I reviewed some of the literature on reading in the context of Arabic and other languages highlighting any influence of proficiency level and working memory on the recall performances and overall comprehension of texts. The studies reported above highlighted two important points. First, most of the studies in the context of Arabic have concerned themselves with the effects of orthographic and phonology on word decoding. Second, there appears to be a consensus that proficiency is correlated with working memory capacity. However, it is not clear which direction is this effect. That is, we do not know whether proficiency is a cause of or an outcome of working memory capacity. My goal is to try to shed some light on this relationship by comparing subjects’ actual performances on the reading tasks adopted in this study with their reports (questionnaire) and verbalizations (interview). Next, I turn to discussing the procedures and materials adopted for the purposes of this study.
Chapter Three: Methodology

In the section, I present the methodology and procedures of the present study. The first section serves as a reminder of the study objectives and the research questions. The second section will provide the research design, a description of the participants, and the materials used in data collection. The last section gives an overview of the statistical measures used in this study.

1. Objectives and Research Questions

The study set out to give an account of reading comprehension efficiency as affected by two independent variables: working memory functions and language proficiency. To this end, five research questions are posed:

a) Are readers’ recall performances affected by their proficiency level?
b) Are readers’ recall performances affected by their working memory functions?
c) Is word-decoding efficiency related to readers’ proficiency level?
d) Are there any correlations between readers’ proficiency level and working memory functions?
e) What is the average reading speed of learners of Arabic as a foreign language?

2. The Experiment

2.1. Participants

The total subject pool for this study was 30. However, 8 were excluded from the analysis due to either low proficiency in the language or failure to follow instructions. The subjects were subdivided into two groups: a proficient group (12 subjects) and a less proficient group (12 subjects). The proficiency level was determined based on subjects’ academic level and overall GPA in Arabic. I opted for these two criterions because in the foreign language context in which
these subjects were tested there is a limited exposure to Arabic outside of the classroom. Therefore, proficiency level is easier to control for in this particular environment and it is relatively safe to assume that placement in class as well as Arabic GPA are accurate measures of proficiency.

All subjects had at least 4 semesters of Arabic at the time of participation. All instructions were explained to the subjects in English before the test and were given a practice text. Prior to this, it was made clear to the students that both the reading texts, questionnaire and interview were undertaken in the framework of a research project whose aim was to determine some reading behaviors among nonnative learners of Arabic, without specifying any aspects of these behaviors.

2.2. Material

The tasks designed for this study adopt Daneman & Carpenter (1980) WM reading comprehension test with some adaptations. In Daneman & Carpenter’s (1980) Reading Span Task, readers are presented with a series of unconnected sentences are asked to read them aloud with the purpose of remembering the final word of the each sentence. Instead, in the present study the subjects were required to read passages and then answer questions that follow without rereading the text. The subjects were given 4 passages to read on each occasion (questionnaire and interview) each followed by 10 questions. The questions were presented on a different (separate) page and subjects were not allowed to go back to the text once they are on the questions page. Questions were presented in multiple-choice format and featured a variety of forms that are aimed at comprehension and recall accuracy. For example, questions samples include pronouns and their referents, words that resemble those mentioned in the text but differ in some key ways (e.g., same root, word form) and recall of specific factual information from the
text and so on. In addition to these subtle cues aimed at assessing the WM functions, subjects were also asked to elaborate on some of these answers during the interview (e.g. how urgent they felt the need to go back to the text), a potential indicator of taxed working memory during reading.

All the reading passages used in this work were matched for length, difficulty and interest. The passages were adapted from Aljazeera’s Arabic learning portal and consist of items from a wide range of topics. The topics themselves were not peculiar or esoteric and were carefully chosen so that they do not demand specific background knowledge. Examples of such readings include the benefits of distant learning, global warming, general health and so on. The reading passages contain both morphologically simple and complex words, a range of syntactic structures, specific information (dates, and facts), and a range of other features aimed at considering the effects of text complexity and informational load on overall retention potential and reading speed. The instructions for the task are given in (1) below.

(1) In this task you are asked to read four passages and the comprehension questions that follow. This is a timed task on both the reading portion and the questions section. Using the digital clock set up for you in the room, please note down the time you started reading before you start reading, and the time you have finished reading after you are done reading (see time slots on each sheet). Please follow the same procedure for the comprehension questions. Once you are on the questions page you may not go back to the text. You may take a break if you need to but only after you have finished a set of reading with its associated questions. You cannot take a break while you are in the middle of reading or answering questions.

2.3. The Quantitative Tests

The questionnaire consists of six sections each designed to elicit feedback on specific component abilities of reading comprehension. The items in the questionnaire contain the following categories: 1) processes that aid comprehension, 2) processes that check and monitor
comprehension, 3) control processes at the word level, 4) control processes at the sentence level, 5) processes for working memory, and 6) inferencing processes (see Appendix B). These processes were chosen as sample key components of the reading component abilities discussed earlier in this thesis, and are by no means comprehensive. The interview included fewer items than the questionnaire. However, all items in the interview were taken from the questionnaire but were rephrased and elaborations were elicited after each question. The interview included the first five categories only. It worth mentioning that the questions were forced choices (See Appendix C).

2.4. Procedure

In order not to give subjects two difficulties at one time, I chose to carry the experiment in two parts. In the first part, subjects were given four short reading texts followed by comprehension questions and a questionnaire at the end. One week later, the second part of the experiment was undertaken, in which subjects were given a different set of reading passages with comprehension questions following each. The procedure here was identical to that of the questionnaire except that here immediately following completion of the task, subjects were interviewed and were asked to verbalize some of the reading behaviors they employed while reading. Verbalization included forced choices and elaborations on their answers. It is worth mentioning that due to time limitations and availability of subjects, only 16 of the original 24 subjects took part in the second part of the experiment; 8 of which belonged to the proficient group, and 8 to the less proficient group. These subjects were randomly selected from the original group of 24 for the purposes of the interview. They were also given clear instructions to base their answers to the questionnaire and interview on the actions they took to understand the texts at hand and in answering the comprehension questions that followed.
2.5. Piloting of the Instruments

Prior to conducting this study, it was deemed necessary to pilot the instruments to make sure that the material was appropriate for data elicitation in terms of linguistic proficiency, length of texts, topics, and that the content of the questionnaire and interview was clearly stated and could trigger the targeted information. The piloting of the instruments took place at a formal academic setting, at the University of Arizona. Six students from intermediate and advanced Arabic classes participated in the piloting. The piloting also benefited from the feedback of a few instructors of Arabic at the department of the said university. The subjects were given four texts to read and a copy of the questionnaire to fill in. They were asked to read the texts the way they would read it either for class or for pleasure and to answer the questionnaire based on the actions they took to process the information. The pilot study confirmed the appropriateness of the reading material and overall reading comprehension (mean average 7.9/10). Percentage of unknown words ranged from 5.25% to 7.80%). Subjects were also asked to give their opinions on the intelligibility of the items of the questionnaire as well as the level of text difficulty.

At a second stage, the piloting aimed to examine the effectiveness of the retrospective interview as an instrument of collecting data on students’ reading processes. Therefore, the six students above were given texts to read before being interviewed. Then they were individually recorded reporting on their reading processes. At the end, they were asked to give their feedback with regards to the questions and the texts. On the basis of this piloting, necessary modifications were made to both content and the structure of the questionnaire and interview, as well as the reading material, to ensure optimal use of the instruments. The piloting of both the questionnaire and the interview helped omit some questions that were not compatible with the purpose of the study or that were repeated in different parts of the questionnaire and including others that were
overlooked such as the ones related to comprehension monitoring. In addition, the piloting showed that the texts and the questions in the interview were appropriate for the purposes of the study.

3. **Statistical Measures**

The mode of analysis of the data from the reading tasks uses both chi-squared test of independence as well as t-test. The rationale for the chi-squared is that the data is mostly categorical. However, since each set of processes in the tests is given an overall percentage of usage, each set was also analyzed as a continuous variable using t-tests. An Analysis Of Variance is also carried out to determine statistical significance between the experimental groups.
CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter is divided into four sections. Section one serves as a reminder of the working hypothesis and the related research questions developed for this study. In section 2, I present the preliminary results on reading time, answer time, and scoring. In light of these preliminary results, section three presents subjects responses to the questionnaire. Section four reports subjects’ verbalizations on the interview. Section five offers a comparison of the results of the two instruments. In section six, I offer a general discussion of the results in light of the working hypothesis of this thesis and the research questions set forth for the present work.

1. The Hypothesis

The working hypothesis in this work is that more proficient readers should exhibit reading behaviors that are different from those of the less proficient groups due to the proficiency level and working memory functions. Under the cognitive theory Anderson’s ACT-R model and a modified version of Kintsch’ CI model within which this work is couched, I predicted that proficient readers should have developed processes that have become procedural in nature; thus, allowing for an autonomous and automatic word recognition process. This path of reading development would also allow for more cognitive and memory resources to be devoted to comprehension and informational retrieval. Therefore, I expected reading times and scores to be lower in the less skilled group due to slower word recognition and sentence parsing. In addition to word level and sentence level differences, this model also predicts that differences should be observed at a metacognitive level, and at the level memory resources available for reading and recollection. Below is a reminder of the research questions of the present study:
a) Are readers’ recall performances affected by their proficiency level?
b) Are readers’ recall performances affected by their working memory functions?
c) Is word-decoding efficiency related to readers’ proficiency level?
d) Are there any correlations between readers’ proficiency level and working memory functions?
e) What is the average reading speed of learners of Arabic as a foreign language?

2. Preliminary results

![Figure 2. Average Reading time for proficient and less proficient groups. Time given in minutes](image)

As seen in Figure 2, the less proficient group spent an average of 5.28 minutes reading each passage while the proficient groups reading time was approximately 4.26. It is worth mentioning that, on average, the number of words per reading passages is approximately 150. This means that the proficient group read about 35.2 words per minute (close to 2 seconds per word 1.71 spw) while the less proficient group read 28.5 words per minute (just over 2 second per word; 2.10 spw).
Figure 3. Average reading time with answer time for both experiment groups. Time given in minutes.

Consistent with the reading times (RTs) reported above are the answer times (ATs) among proficient readers (PRs) and less proficient readers (LPRs). Figure 3 shows that LPRs spent more time answering the comprehension questions (3.79 m) than did the PRs (3.15 m).

Figure 4. Mean scores on the comprehension tests for both experimental groups.

Figure 4 shows that PRs scored higher (8.12/10) in the comprehension questions than did the
LPRs (6/10). The higher scores are also consistent with the faster RTs and ATs reported above. An analysis of variance (ANOVA) revealed significant differences between the PR group and LPR group (p <.002). A summary of the preliminary results is shown in Table 1 below. Analysis of variance is summarized in Table 2 below.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Reading Time</th>
<th>Answer Time</th>
<th>Reading Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proficient Mean</td>
<td>4.3175</td>
<td>3.1500</td>
<td>8.125</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.98831</td>
<td>1.25037</td>
<td>1.5244</td>
</tr>
<tr>
<td>Less Proficient Mean</td>
<td>5.0683</td>
<td>3.7992</td>
<td>6.000</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>2.46832</td>
<td>1.17393</td>
<td>1.4302</td>
</tr>
</tbody>
</table>

Table 1. Summary report of RTs, ATs, and RSs.

<table>
<thead>
<tr>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>.344</td>
<td>-.75083</td>
<td>.76754</td>
</tr>
</tbody>
</table>

Reading Times

<table>
<thead>
<tr>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>.203</td>
<td>-.64917</td>
<td>.49511</td>
</tr>
</tbody>
</table>

Answer Time

<table>
<thead>
<tr>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>.002</td>
<td>2.1250</td>
<td>.6034</td>
</tr>
</tbody>
</table>

Reading Scores

Table 2. Variances between the two groups
3. The Questionnaire

The data, broken down by category and experimental group, is summarized in Figure 5. In this and the subsequent figure of the interview results, the usage proportion refers to the number of processes that readers checked yes to (as something they employ). Higher usage generally means that the reader uses/relied on that category often.

A few remarks regarding the data above are in order. LPRs reported higher usage of reading processes (.63) to aid comprehension. As for the check (monitoring) category no significant difference in the usage proportion was found between PRs and LPRs (.52 and .54 respectively). Same is noted for the control category at the word level. By contrast, PRs reported using higher...
proportion of control processes at the sentence level (.65 for PRs compared to .58 for LPRs). As for the WM category, LPRs reported slightly higher usage in this category (.52 for LPRs compared to .47 for PRs). It is worthy to mention that in the WM category questions were designed to elicit how much pressure readers felt while reading and answering comprehension questions; therefore, higher usage proportion is an indicator of a taxed WM. Finally, the reported inferencing processes of both groups were comparable in usage proportion (.52 for PRs compared to .56 for LPRs). Overall, no statistically significant difference was found in the usage proportion between the two experimental groups (see table 4 below). A summary report of the results above is in table 3. Analysis of variance between the two experimental groups is summarized in table 4 below.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Aid Comp.</th>
<th>Check/ Monitor</th>
<th>Control-Word</th>
<th>Control-Sentence</th>
<th>Working Memory</th>
<th>Inferencing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proficient</td>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>.5385</td>
<td>.5625</td>
<td>.5208</td>
<td>.6500</td>
<td>.4792</td>
<td>.5208</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.15730</td>
<td>.21651</td>
<td>.22508</td>
<td>.21106</td>
<td>.12873</td>
<td>.29113</td>
</tr>
<tr>
<td>Less Proficient</td>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>.6346</td>
<td>.5417</td>
<td>.5417</td>
<td>.5833</td>
<td>.5208</td>
<td>.5625</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.13573</td>
<td>.27866</td>
<td>.23436</td>
<td>.21672</td>
<td>.19824</td>
<td>.21651</td>
</tr>
</tbody>
</table>

Table 3. Summary report of usage proportions in the six categories of the questionnaire.
### Table 4. Variances between PRs and LPRs in the six categories of the questionnaire.

<table>
<thead>
<tr>
<th>Category</th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aid</td>
<td>.142</td>
<td>.12821</td>
<td>.08411</td>
</tr>
<tr>
<td>Monitor</td>
<td>.614</td>
<td>-.10417</td>
<td>.20364</td>
</tr>
<tr>
<td>Control-word</td>
<td>.639</td>
<td>-.08333</td>
<td>.17498</td>
</tr>
<tr>
<td>Control-sentence</td>
<td>.106</td>
<td>-.23333</td>
<td>.13835</td>
</tr>
<tr>
<td>Working Memory</td>
<td>1.000</td>
<td>0.00000</td>
<td>.13990</td>
</tr>
<tr>
<td>Inferencing</td>
<td>.783</td>
<td>.04167</td>
<td>.14944</td>
</tr>
</tbody>
</table>

Having quantified the results from the questionnaire, let us now turn in to the next section to see whether or not the interview responses are consistent with those of the questionnaire.

### 4. The Interview

First, it should be noted that the items included in the interview represent only sample processes from each of the categories in the questionnaire. The rationale behind the inclusion of these items is to seek personal feedback from subjects on some key aspects in the following categories: Aiding comprehension, monitoring comprehension, control processes at the word level, control processes at the sentence level, and working memory capacity. The interview did not include the inferencing category. Below is a summary of the results.
A few observations follow from figure 6. First, it appears that differences in usage proportions between the two experimental groups are more pronounced. This could be attributed to either the random sampling of 8 subjects from each group or the inherent nature of the verbal protocol, or both. While the interview structure was based on forced choices (yes or no), many subjects, upon elaborating on their responses decided to change their responses based on their own verbalizations. For example, in the working memory category, LPRs expressed a dire urge to go back to the reading passage in order to answer the questions.

First, an opposite pattern is observed at the level of processes that are reported to aid in comprehension. Here, PRs reported more usage in this category (.62 in PRs compared to .55 in LPRs). As for check/monitoring processes, subjects from the PR group reported a much higher use of these “metacognitive” processes than the LPR group (.87 and .52 respectively). Consistent with the results obtained through the questionnaire, both LPRs and PRs reported similar usage of control processes at the word level. Additionally, and similar to what has been reported in the questionnaire, PRs reported higher usage of control processes at the sentence level (.79 in PRs...
compared to .75 in LPRs). Last, but not least, LPRs verbalizations showed a high usage proportion in the working memory category than PRs (.87 and .50 respectively). However, only two categories (i.e. Monitor and Working Memory) reached statistical significance (p<.000 and p< .003, respectively). Table 5 summarizes the results discussed above and table 6 shows the variance between the two groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Aid</th>
<th>Check</th>
<th>Control-Word</th>
<th>Control-Sentence</th>
<th>Working Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proficient Mean</td>
<td>.6250</td>
<td>.8750</td>
<td>.5625</td>
<td>.7917</td>
<td>.5000</td>
</tr>
<tr>
<td>N</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.13252</td>
<td>.14773</td>
<td>.25877</td>
<td>.17252</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Aid</th>
<th>Check</th>
<th>Control-Word</th>
<th>Control-Sentence</th>
<th>Working Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less Proficient Mean</td>
<td>.5568</td>
<td>.5208</td>
<td>.5938</td>
<td>.7500</td>
<td>.8750</td>
</tr>
<tr>
<td>N</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.13252</td>
<td>.16517</td>
<td>.22903</td>
<td>.23570</td>
<td>.23146</td>
</tr>
</tbody>
</table>

Table 5. Summary report of usage proportions in the five categories of the interview.

<table>
<thead>
<tr>
<th></th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aid</td>
<td>.321</td>
<td>.06818</td>
<td>.06626</td>
</tr>
<tr>
<td>Monitor</td>
<td>.000</td>
<td>.35417</td>
<td>.07835</td>
</tr>
<tr>
<td>Control-word</td>
<td>.802</td>
<td>-.03125</td>
<td>.12218</td>
</tr>
<tr>
<td>Control-sentence</td>
<td>.693</td>
<td>.04167</td>
<td>.10327</td>
</tr>
<tr>
<td>Working Memory</td>
<td>.003</td>
<td>-.37500</td>
<td>.08183</td>
</tr>
</tbody>
</table>

Table 6. Analysis of variance between the two experimental groups in the interview.
5. **Comparison of the Quantitative Tests**

To a large extent, the results of the verbal protocol and the survey are complementary (with a few differences that will be discussed below). The differences could be an artifact of the methodology (different instruments & population size). That is, this inter-reader variability could be due to the highly formal nature of the survey versus the semi-structured nature of the interview (and slightly different phrasing of questions). First, with the exception of the Aid processes category, which showed opposite patterns, all of the other categories were consistent across tests in terms of usage direction (i.e. higher or lower). However, the usage proportions tended to be more pronounced in the verbal protocol than they did in the questionnaire. For example, while LPRs reported higher usage of monitoring processes in both the questionnaire and the interview, the differences in usage proportion was much higher in the interview. PRs responses reached .87 in the interview, whereas their responses to the questionnaire were marked at .56 (.35 difference). Thus, the interview highlighted more metacognitive processes. The interview also revealed that readers from the LPR category felt more pressured to answer correctly which reflected on their responses to the WM category.

6. **Summary of the Experiments**

The results of the experiment presented here validate the hypothesis put forth at the beginning of this thesis. Reading times, answering times, and scoring are indicative of the proficiency level of readers and their working memory capacity. The results of the follow up instruments confirm these results. Less proficient readers scored lower on the reading comprehension tasks and spent relatively more time reading passages and answering questions. There are two predictions that could help us interpret these results. First, this could be a function
of an undeveloped vocabulary base in the less proficient group and a more developed one in the case of more skilled readers. Second, this could be a product of teaching practices that emphasize inferencing strategies over building vocabulary.

Taken together, the results from both tests explain the RTs, ATs and RSs obtained from the reading passages. Proficient readers appear to be more reliant on metacognitive processes that help monitor comprehension and ensure that comprehension has occurred. This is consistent with what has been reported in research that successful readers are aware of their reading behaviors and continuously and consciously monitor their reading. While I hypothesized at the beginning of this work that less skilled readers would be more likely to deploy several control processes at the word level to ensure successful decoding, the findings of this study shows that both the LPRs and PRs reported similar usage proportions of processes at the word level (although slightly higher in the less proficient category). Granted that differences between the two groups could be sought in how effective they are at using those processes, it is also possible that the less skilled category is more geared towards reading the entirety of the word, whereas the more proficient category is likely to sight words, thus allowing for faster reading rate. In what follows, I offer an interpretation by category.

- With regards to general comprehension processes (Aid category), more data is needed to address the opposite patterns observed in this category. However, the questionnaire appears to show a larger difference in usage proportion between the two experimental groups. I will take the questionnaire responses to be more reliable since it included more items than the interview. In this case, we can interpret the higher usage proportion among the LPRs to be a compensatory course for a deficiency in another area.

- As for comprehension monitoring, as expected, skilled readers reported using more
monitoring processes while reading in order to check their comprehension and demonstrated higher awareness of reading processes as evidenced by the number of strategies they reported during the interview (O’Reilly & McNamara 2007).

- Concerning control processes at the word level, earlier in this thesis I established that word knowledge plays a crucial role in explaining individual differences between skilled and less skilled readers. However, the results reported here only partially support this hypothesis. That is, while reading speed indicates faster word recognition among the proficient readers, the reports show that both groups’ usages of such processes are comparable (with a slight edge for skilled readers). However, this should not be interpreted to mean that both experimental groups use these control processes in the same way. In fact, the reading times support the hypothesis that automaticity is the result of a well developed vocabulary which comes as a result of highly proceduralized actions at the level of words. Conversely, a slower speed among LPRs is taken to indicate a less developed vocabulary, which in turn affects how semantic spreading activation is carried out (Colthart et al 2001). Thus, although both groups reported using similar processes, how well they carry out such processes is contingent on both vocabulary breadth and depth.

- In the sentence control category, there was a clear pattern of usage in which LPRs reported less usage of parsing mechanisms and sentence control processes. These results could be interpreted to be a byproduct of lower grammatical knowledge, which is an important skill for meaning building and syntactic parsing. The results confirm the argument put forth by Perfetti, Landi, & Oakhill (2005) and Fender (2001) that syntactic parsing is continuously involved in comprehension and has a measurable impact on
reading processing time.

- With regards to working memory functions, the findings that less skilled readers perform poorly on questions that address text-based or implicit inferences are confirmed by the results of the present study. Skilled readers outperformed their less skilled counterparts in this category and did so with more confidence as reflected by their answering times. The hypothesis put forth in this study, that having fewer resources in WM affects comprehension that in turn affects recall accuracy, is confirmed by the results reported here. The working memory attentional resources availability is interpreted to be a byproduct of fast and automatic word recognition.

- Finally, the reported inferencing processes are based solely on the questionnaire. While the usage proportion was comparable, it was slightly higher among the LPRs. Recall that Inferencing is a higher-order skill that indicates that the reader is able to span larger parts of the text in order to make sense of printed information. The reported usage proportions here are surprising given that the ability to make inferences comes at a memory resource cost since the demands to keep information active for large parts of the text is higher. A possible explanation for this slightly higher usage in this category is that LPRs are more dependent on context. In the case of higher proficiency group, it could be the case that readers in this group are less dependent on context. The reason here being that context takes more time to register for the proficient group and that fast reading obviates the need for support from contextual clues (Pressley, 2006 & Stanovich, 2000).

Furthermore, since inferencing ability allows readers to suppress information they deem irrelevant or not likely to be tested on, it could also be the case that LPRs are making judgments regarding which information will likely be subject of the questions to follow.
Finally, an interesting observation about two very closely related categories (i.e. inferencing and monitoring) is in order. Often times, connections between some details of reading passages are not explicitly stated, requiring that the reader generate inferences to fill in the missing information. The fact that these two categories showed positive correlation in this study indicates that online monitoring of comprehension is crucial in constructing meaning and that by making inferences readers establish missing links across text segments.
CHAPTER 5: CONCLUSIONS

1. General Discussion

Throughout this work, I have tried to show that the cognitive model of ACT-R as proposed by Anderson (2007) along with Kintsch’s Construction-Integration model of (CI) is most appropriate for an analysis of reading behaviors among skilled and less skilled readers. So far, I have shown that an analysis within this framework adequately accounts for the differences that exist among skilled and less skilled readers in terms of reading outcomes, decoding efficiency as reflected by reading speed and scores, and the level of confidence as reflected by the answering time on the reading tasks. This study set out to investigate relationships among proficiency level, reading processes and working memory functions among non-native readers of Arabic. For this reason, five research questions were posed (1) Are readers’ recall performances affected by their proficiency level? (2) Are readers’ recall performances affected by their working memory functions? (3) Is word-decoding efficiency related to readers’ proficiency level? (4) Are there any correlations between readers’ proficiency level and working memory functions? (5) What is the average reading speed of learners of Arabic as a foreign language?

With regards to the first question, it was found that PRs outperformed LPRs on the reading comprehension tasks suggesting a strong correlation between proficiency level and recall performances. While correlation does not necessarily imply causality, comprehension, which is a strong indicator of proficiency, is a prerequisite for accurate recall of textual information. Thus, higher proficiency contributes to higher information retention. As a byproduct of the differences in proficiency level, recall performances are also likely to manifest differentially in reading scores.
As for research question #2 & 3, the findings of the present study point to a strong correlation between working memory capacity/function and readers’ recall performances. To answer this question one has to look at several sources of difficulty that could cause working memory attentional resources to be diminished as a function of proficiency level. Such sources of difficulty include word length, visual properties of words, graphemic similarities, word order, recency effect (e.g. referential pronouns) and grammatical complexity (e.g. morphologically and syntactically complex sentences). The gains in automaticity in word recognition as discussed under the ACT-R cognitive framework is most apparent in terms of reading speeds which was found to be much faster in proficient group. The hypothesis at work here is not that skilled readers have more capacity (although this could be true); rather, the assumption being made here is that skilled readers have a more automatic word decoding capacity that allows for memory resources to be freed up and allocated to other textual information processing.

Regarding research question #4, working memory capacity is strongly correlated with proficiency level. Having shown that working memory is strongly correlated with recall performances it should be pointed out that it is not entirely clear whether proficiency level increases as a function of working memory capacity or that the latter leads to increases proficiency. It is noteworthy here that while working memory functions have not played a large role in comprehension theories, the results reported here confirm a strong correlation between working memory, reading processes, proficiency level and reading outcomes. The results reported here indicate that there is a need to incorporate working memory capacity in reading models as it appears to have an explanatory power in terms of readers’ proficiency level variability.
Finally, the reported reading times on the reading tasks are consistent with research findings in the context of Semitic languages which have shown that readers of Arabic (and Hebrew) read at a much slower rate than has been established in other languages (Saiegh-Haddad, 2003; Eviatar and Ibrahim, 2004; Abu-Rabia, 2001). The first generalization that could be made about this finding is that word decoding efficiency in Arabic is significantly affected by the orthographic properties of the Arabic language, at least in the context of foreign language learners. For native speakers, there are additional factors that have been shown to also affect the reading speed such as the effect of diaglossia and the distance between the written form and the spoken form of the language (Saiegh-Haddad 2014).

In conclusion, the current paper supports Daneman and carpenter’s (1980) conclusion that working memory is continuously involved in language comprehension. Any measure that taxes readers’ working memory (storage and processing) will show varying degrees of effects on reading outcomes depending on the proficiency level of readers. Thus, working memory and proficiency level are two predictive factors of reading comprehension outcomes. The effect of these factors is non-trivial and should be taken seriously into consideration when assigning reading tasks so that both task difficulty and text difficulty are factored in. In the following two sections I will make some recommendations for Arabic language teachers and researchers.

2. Implications for Teachers

The gains in Arabic reading research have direct and obvious implications for classroom instruction. In what follows, I will suggest ways to develop comprehension in the classroom, and highlight the importance of enhancing attention to reading comprehension. In many language classrooms, reading isn’t given instructional priority. The reading research should also inform
our assessment tools. Undoubtedly, the comprehension assessment tools common in language classroom reflect instructors’ (and is limited to) understanding of the reading processes underlying reading comprehension.

The results of this study taken together, and contrary to the common practice of presenting reading passages loaded with unfamiliar vocabulary items and asking students to continuously decode and figure out word meaning on top of understanding the text’s message, emphasize the importance of vocabulary building. As Hanson (2010) notes: “texts should be understood so easily that learners’ cognitive capacity can be directed toward word recognition alone-instead of an analytical process” (Hanson, 2010 p.579).

Building on the results of this study, it can be deduced that teachers should not take for granted that their students become strategic readers as they advance in their studies. Importance needs to be placed upon developing learners’ reading strategies even at advanced levels. Further, readers of Arabic need to be trained on how to use high level reading skills such as reading for global meaning and monitoring comprehension. This means that teachers will need to devise activities where students are asked to distinguish between the most and least important ideas, to transform information, summarize parts of the text, and ask questions aimed to evaluating text meanings and ideas. The objective then is to go beyond enlarging students’ lexical repertoire. Hence. Reading classes need to focus on improving the reading skills of the reader and to raise their awareness about their reading behaviors. One example can be drawn from the methodology of this study itself. Teachers can ask their students to read texts and to report their reading processes afterwards. Although, many of these processes may not be verbalized initially due to their subconscious nature (as an unobservable behavior), the reader will eventually develop the metacognitive awareness needed to reflect on his/her thinking. This will make students aware of
their strength and weaknesses as readers and will encourage them to look for ways to improve
their reading behavior. Students need to be sensitized to the nature of the reading process and
their attention should be drawn to the processes that enhance comprehension. Finally, without
adequate support, many students with reading comprehension difficulties may be unable to
compensate for the many difficulties that they experience in understanding what they read.

As it has been pointed out above, vocabulary knowledge is a strong predictor of overall
reading comprehension outcomes. Vocabulary depth is a measure of richness and
interconnectedness of a reader’s meaning networks, which is very crucial for making inferences
and supporting reading. The implication of these findings is that vocabulary should be taught
both directly and indirectly. That is, words may be taught directly by giving explicit definitions,
pre-teaching of core vocabulary before reading texts as well as indirectly by enhancing readers’
ability to infer and refine meanings from the text. The point to be made here, and one this is
often overlooked by instructors, is that it is not always about teaching new words. In addition to
teaching new vocabulary, it is also crucial to train readers to improve on what they already know
about their vocabularies. As Nagy and Herman (1987) pointed out it, “the size of the task is such
that just teaching more words cannot be seen as the answer”.

Recognizing words in Arabic entail knowledge of phonemes, orthographic patterns,
semantic meanings, syntactic uses, and morphological roots and affixes. Therefore, the things to
consider when teaching vocabulary include: morphology (prefixes, roots, suffixes, inflections),
orthography, vocabulary access, vocabulary breadth, and vocabulary depth. There is evidence
that substituting easier vocabulary for harder words and instructions in the meaning of more
difficult words improve comprehension (Kameenui, Carnine, & Freschi, 1982). Although the
research base at this point is not strong enough to recommend the best way to teach vocabulary,
there are some recommendations that can be made. Successful teaching of vocabulary should be directed at deeper levels of vocabulary knowledge. Words can be linked to many words and concepts in a “semantic network”. In practice, this means that vocabulary should take place in a rich context (National Reading Panel NRP, 2000). Other recommendations would be to ask increasingly demanding questions about new words, and provide opportunities to rehearse old and new vocabulary.

3. Directions for Future Research

The research reviewed in this paper provides many insights about the processes underlying readability and text comprehension among nonnative readers of Arabic. It also reveals a number of areas in which additional research is needed. Greater benefits can be gained if a combination of retrospection and introspection was used and if subjects from various backgrounds and locales were involved. Longitudinal studies examining the progression of reading processes and abilities among nonnative readers of Arabic are needed in order to pinpoint exactly to developmental shifts that occur. In the present work, I have opted for a different measure of working memory, which is integrative in nature. Traditionally, working memory is measured by span tasks in which reading (or arithmetic) material is presented in a list of words (or last words of sentences as in Daneman and Carpenter, 1980 research) and the subjects are asked to repeat the material verbatim (and in the same order) after some delay. In this thesis, I have attempted to measure the working memory load implicitly by measuring subjects, reading times, answer times, comprehension scores, and their level of confidence in answering and recalling textual information. The hypothesis I have underscored in this research is that readers with more working memory to spare should score higher, read faster and feel more confident answering comprehension questions that followed. Future research is encouraged to
conduct a dual paradigm research in which traditional methods of the reading span type, as well as integrative methods such as the one employed here. Such dual paradigm would make it possible to compare information retainability in tasks that do not require information integration of the sort found in traditional literature on working memory, and real life tasks (e.g. reading comprehension) that requires both information hold in working memory and the manipulation of such information in order to integrate text information to build text meaning.

An examination of teaching style, time allocated for reading in class, and practice effect would also contribute to our understanding of when and how knowledge of reading processes become proceduralized. Precise measures for the level of proficiency of subjects would yield and even more accurate result. In addition, exploratory research in reading comprehension can investigate the relationship between reading processes and reading tasks. Evidence from neurocognitive science could explain such development shifts.

The evidence reported in this study point to a need for a more unified theory of reading comprehension that takes as its basis a variety of factors and mechanisms including, differences in working memory capacity, differences in vocabulary acquisition, and metacognitive awareness of one’s own reading abilities. Such theory would not only explain the proficiency level influence on reading, but also has the potential in to explain within-reader variability and individual differences. Further investigation of these variables and how they interact with one another should contribute to our understanding of how and when certain reading processes emerge and what language instructors should be alerted to at each phase of reading comprehension development. Further evidence is also needed to examine the effects of proficiency level and linguistic knowledge on specific component abilities of reading such as orthography, and morphological decomposition skills.
4. Limitations

The present study suffers from a number of limitations. First, it is limited in terms of representativeness. Obviously, the sample does not represent all non-native speakers of Arabic at the college level. The subjects belong to the same university, which makes it difficult to generalize the results. Besides, no test was administered to determine the level of proficiency level of these subjects. Instead, the academic level, along with GPA score, was used as a basis to divide the groups into proficient and less proficient readers. Although, as I have had cause to mention, it is relatively safe in the context of foreign language learning environment, a proficiency measure such as ACTFL Oral Proficiency Interview or the Reading Test for professionals (RTP) would have been more accurate and more appropriate to find out subjects real linguistic competence. In fact, to account for individual differences one has to look at ability differences in addition to grade level differences. Retrospection also adds to the limitations of this study. Though some measures have been taken to use it as effectively as possible, this procedure, if unaccompanied with think aloud protocols, does not provide full access to subjects’ reading processes, especially with regards to non-observable and subconscious processes. Therefore, any conclusions on the basis of this study should be drawn cautiously and in light of the subjects’ characteristics and the instruments adopted for data elicitation. The study is also general in nature as it tries to look at the effect of several factors taken together on the reading process. A breakdown of all components would allow for a better understanding of the development of reading.
اللغة العربية: الرابعة في بروكسل

أظهرت دراسة أعدتها جامعة بروكسل أن اللغة العربية أصبحت تحتل حاليًا المركز الرابع من مجموع 104 من اللغات المستعملة في العاصمة البلجيكية, عاصمة الاتحاد الأوروبي, وذلك بعد الفرنسية والإنجليزية والهولندية, مع ففزة كبيرة منذ عام 2006. ويعدت الدراسة بناء على طلب من حكومة المنطقة الفلاندر, بشمال البلاد, حول مقياس استخدام اللغات في بروكسل. وورد في نتائج الدراسة أن حوالي 20% من سكان العاصمة الأوروبية يتحدثون اللغة العربية.

وأشارت الدراسة إلى أنه, وخلال ست سنوات فقط, ارتفع عدد الذين يعلنون عن التحدث, بشكل رئيسي, بالعربية من 6.6% إلى 17.9% وأكدت أن ذلك يرجع إلى التركيبة السكانية لمدينة بروكسل. وتستخدم في بروكسل حاليا 104 لغات مقابل 72 فقط عام 2000, وهو ما يعني أن التنوع اللغوي أصبح قاعدة بالعاصمة البلجيكية.
I. Determine whether the following statements are true or false:

<table>
<thead>
<tr>
<th>False</th>
<th>True</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

1. أُعدت جامعة بروكسل دراسة عن استخدام اللغات.
2. عشرون في المائة من سكان أوروبا يتحدثون العربية.
3. زاد عدد المتكلمين بالعربية في بروكسل.
4. أصبح المتكلمون بالعربية أكثر من المتكلمين بالفرنسية.
5. العاصمة البلجيكية هي عاصمة الاتحاد الأوروبي.

II. Choose the right answer for each of the following statements:

1. بعد عام 2006:
   - □ استقر عدد المتكلمين بالعربية
   - □ انخفض عدد المتكلمين بالعربية
   - □ ارتفع عدد المتكلمين بالعربية

2. من أعد هذه الدراسة؟
   - □ جامعة بروكسل
   - □ الاتحاد الأوروبي
   - □ حكومة بروكسل

3. كم عدد اللغات المستعملة في بروكسل؟
   - □ عشرون
   - □ مائة وأربعة
   - □ أربعة

4. ما نسبة المتكلمين بالعربية في بروكسل؟
   - □ سبع عشر في المائة
   - □ ستة في المائة
   - □ عشرون في المائة

5. ما سبب هذا الارتفاع؟
   - □ دراسة اللغات
   - □ التركيبة السكانية للمدينة
   - □ تعليم العربية

Finish time: ____________________
التّعلم عن طريق الإنترنت

**distant learning**

يُعتبر التّعلم عن طريق الإنترنت أو التعليم عن بعد 1 خياراً ملائماً للكثيرين، ولكن هناك من يرى أن التّعلم التقليدي يظل الخيار الأفضل.

**mythology**

يقول الأستاذ ستارك الذي يدرس علم الأساطير 2 عن طريق الإنترنت إن التّعلم المفتوح أصبح ملذاً للذين لم تستوعبهم الفصول الدراسية التقليدية ولذين لا يستطيعون دفع رسوم مربحة. كما تحقق هذه التقنية أكبر قدر ممكن من التكافؤ في الحصول على فرص التّعلم في جو تفاعلي 4 أقرب إلى الواقع.

**high charges**

طلاب الأساتذة ستارك ينتشرون في دول متفرقة من العالم ويستطيعون الوصول إلى محاضراته وتحميلها من خلال مواقع أُعدت خصيصاً لهذا الغرض. وتقول طالبة إن التعليم عن طريق الإنترنت يجعل الأمور أكثر سهولة.

**interactive**

ولكن رغم هذه السهولة فهناك ماخذ كثيرة على هذا النوع من التعليم حيث يرى منتقدون 5 أنه يفقد إلى التّفاعل الآلي 6 الكامل مهما أنه قد لا يكون بمثل جدّية التعليم التقليدي. كما يدعي منتقدو التعليم المفتوح عن طريق الإنترنت أنه لا يضمن للطلاب شهادات تعليمية في طرق باب العمل.

Finish time: __________________
I. Determine whether the following statements are true or false:

<table>
<thead>
<tr>
<th>False</th>
<th>True</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>□</td>
</tr>
<tr>
<td>7.</td>
<td>□</td>
</tr>
<tr>
<td>8.</td>
<td>□</td>
</tr>
<tr>
<td>9.</td>
<td>□</td>
</tr>
<tr>
<td>10.</td>
<td>□</td>
</tr>
</tbody>
</table>

II. Choose the right answer for each of the following statements

2. التعليم عن بعد:
- لا يساعد في الحصول على عمل □
- يساعد الباحثين عن العمل □
- يوفر إمكانيات للحصول على عمل □

3. تقنية التعليم المفتوح:
- تشكل فرصة للجميع لتمثيل دراستهم □
- يستخدمها القليل من الطلاب □
- تساهم على التفاعل بين الطلاب □

4. من يلجأ إلى التعليم المفتوح:
- الذين يستطيعون دفع رسوم مرتفعة □
- الذين لم يتمكنوا من متابعة دراستهم □
- الذين يريدون الذهاب إلى الفصول الدراسية □

5. تقول الطالبة أن:
- الدراسة عن طريق الإنترنت صعبة □
- الدراسة تتم عن طريق الكمبيوتر □
- الدراسة عبر الإنترنت أكثر سهولة □

6. من المأخوذ على التعليم عن بعد:
- أنه يفقد إلى التفاعل المباشر □
- أنه يحتاج إلى الكثير من الوقت □
- أنه يختلف عن التعليم التقليدي □
Appendix B – The Questionnaire

This survey is part of a study that attempts to investigate the reading behavior of learners of Arabic as a second/foreign language. This study has practical implications for both the teaching and learning of Arabic to non-native speakers. Your contribution is highly appreciated. If you have any comments, please note them down at the end of this questionnaire.

Personal Information:

Level:

<table>
<thead>
<tr>
<th>ARB - 401</th>
<th>ARB - 402</th>
<th>ARB - 406</th>
<th>ARB - 408</th>
<th>Other (please specify)</th>
</tr>
</thead>
</table>

GPA:

Current Arabic GPA (Estimated Grade): _______________. Current Overall GPA: _______________.

Gender:

- Male
- Female

Age: _______________.

General Questions:

How would you assess your reading ability in English?

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Above average</th>
<th>Average</th>
<th>Less than average</th>
</tr>
</thead>
</table>

How would you assess your reading ability in Arabic?

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Above average</th>
<th>Average</th>
<th>Less than average</th>
</tr>
</thead>
</table>

Part One: Processes that aid comprehension

1. When you were reading the text, what are the things that helped you understand the text? (You can base your answers on your reading of other texts in Arabic as well) | Helped | Did not make a difference | made it worse |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reading the title of the text</td>
<td>Making predictions about the content of the text immediately after reading the title</td>
<td>Paying attention to all details</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
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<td></td>
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<td>j</td>
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<td>k</td>
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<td>l</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Part Two: Processes to monitor comprehension

To make sure you have understood the text after reading it, you:

<table>
<thead>
<tr>
<th></th>
<th>To make sure you have understood the text after reading it, you:</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Think about what you learned that you didn’t know before</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Figure out ways to ensure you remember text information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>Make your own questions about the reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Evaluate and monitor your understanding of the reading</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part Three: Control Processes

A- Word Level

1. If you find a difficult word while reading a text in Arabic, you:
   a. Ignore the word and go on reading
   b. Pronounce the word to trigger its recognition
   c. Recall words with similar meanings or word forms
   d. Relate the word to another word in English or other languages
   e. Break it down into prefixes, roots, and suffixes (e.g. كتاب/مكتبة/مكتوب)

B- At the Sentence Level

2. When you find it difficult to understand a sentence, you:
   a. Generate connections to local and distant sentences to infer any causal relations
   b. Analyze the sentence structure and draw on your understanding of grammar rules and parts of speech (e.g. Word order, subject, verb, predicate etc.)
   c. Use context to determine links between events (e.g. causal, referential, spatial etc.)
   d. Rely on the authors intentions to make a guess
   e. Use punctuation marks to determine sentence organization

Part Four:

A -

1. Remembering what:
   a. You felt an urgent need to go back to the text to answer comprehension questions
   b. You slowly and carefully match letters of a word with their corresponding sounds
### C. Reading Strategies

- **c.** You read the text more than once
- **d.** You find it difficult to remember most factual information contained in the texts (e.g. dates, facts, names etc)
- **e.** You find it hard to stay focused on the reading task and are easily distracted
- **f.** You find that unfamiliar words slow you down while reading

### B - Inference-making:

2. **Inference-making:**

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>You find it difficult to answer questions that required integrating information between two or more sentences?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>You draw on your personal experience and world knowledge to infer cause-and-effect links between text events?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>You make personal assumptions about the author’s intentions and text purpose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>You read between the lines and make judgments about the accuracy of your text understanding.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Further comments or suggestions:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Thank you for your participation!
Appendix C – Sample Cue Items from the Interview

1. How did you start reading the text?

2. What are some of the things you were thinking about when you started reading?

3. Did you try to predict what the text is about after reading the title or the first paragraph?

4. Was the structure of the text of any help to you?

5. Do you typically analyze words and break them down into various components (e.g. roots, affixes, suffixes)?

6. Do you try to figure out the meanings of unfamiliar words based on analogies to similar sounding words (e.g. share similar pattern)?

7. Do you typically consciously monitor whether the meanings you have inferred are appropriate? Do you check the inferred meanings against the wider context?

8. Do you find that a lot of the words in the readings that you did were difficult? If yes, what made them difficult?

9. Do you find that familiarity with the text topic is necessary to adequately comprehend the text at hand? What kind of previous knowledge helped understand the text?

10. Did you underline some ideas in the text? Why? How did you determine which bits of information were more important/salient?

11. Did you find the vocabulary items translated into English to be useful? Were they all new to you?

12. Do you rely on your knowledge of verb “Awzan” (patterns) to understand sentence structure?

13. Did you translate some words or sentences into English? Why?

14. What are the things that you focused on more while reading the text?

15. How did you know you understood the text?

16. What are some of the difficulties that you faced while reading the reading passages?

17. How did you react to these difficulties? How did you go about in remedying difficult aspects of the text?
18. Did you find the meanings of most sentences to be straightforward? How much did you feel your background knowledge has helped you in understanding the text answering comprehension questions?

19. On average, did you feel that you understood the reading passages well enough to comfortably answer the comprehension questions that followed? How did you know you understood the text?

20. Did you feel the need to reread some parts of the texts more than other parts? Why?
REFERENCES:


(Original work published 1908)


Kirby, J.R. and Savage, R.S., 2008. Can the simple view deal with the complexities of reading?. *Literacy, 42*(2), pp.75-82.


