Lower-level Processes of L2 Reading Comprehension: Linguistic Knowledge and Processing Skills in Arabic-Speaking Readers of English as a Foreign Language

Submitted By

Mona Alshehri

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

This thesis involves two distinct studies towards understanding the lower-level of second language (L2) reading comprehension processes: word recognition and word-to-text integration and their respective underlying linguistic knowledge and skills. The data was collected from 268 adult Arabic-speaking readers of English as a Foreign Language (EFL) at one of the Saudi universities, the same group of participants for both studies. A battery of paper and computer-based tests was administered, on a group and individual basis, to measure the participants' lexical competences, syntactic knowledge, reading comprehension ability, and working memory. Some of these variables were included in both studies for different purposes.

Study 1 highlights the Lexical Quality Hypothesis, which contends that high-quality representations of lexical and sub-lexical features are fundamental for the first critical process of reading comprehension, which is word recognition. It underscores the importance of lexical processes in reading comprehension. Therefore, it focused on the sub-lexical and lexical processes (underpinning word recognition) in L2 reading comprehension. The participants' sub-lexical/morphological knowledge (knowledge of word parts, such as derivational affixes) and lexical knowledge (knowledge pertaining to word form–meaning relationships, more commonly known as vocabulary size knowledge) were measured through a set of paper-based tasks. In addition, their morphological processing (morphological segmentation and combination) and lexical processing (lexical decision) skills were measured with computer-based decision tasks. This study examined how these distinct processes – knowledge vs. processing efficiency on the one hand and sub-lexical/morphological vs. lexical on the other – collectively and relatively predicted the participants' reading comprehension, after controlling for the effect of working memory. Hierarchical regression analyses revealed that over and above working memory, both lexical and sub-lexical knowledge were significant and unique predictors of reading comprehension, and sub-lexical processing efficiency, as opposed to lexical processing efficiency, significantly predicted reading comprehension. Additionally, among the measured lexical competences, lexical knowledge was the strongest predictor; and the two knowledge variables collectively had a far more significant influence on reading comprehension than the two processing efficiency variables. These findings are discussed in light of

the lexical basis of L2 text comprehension and underscore the importance of knowledge of word meanings in developing L2 readers.

Recognition of individual words serves as an initial basis for comprehension of a written text. Yet, there are complex word-to-text integration processes underlying text comprehension. The second study focused on comparing the two distinct components of the word-to-text integration process, that is syntactic parsing and semantic association, in L2 reading comprehension. The participants' syntactic knowledge (grammatical error correction) and semantic network knowledge (semantic association) were measured with paper-based tasks. The study assessed how syntactic and semantic network knowledge, controlling for working memory and vocabulary knowledge/size, differentially predicted two types of text comprehension (literal vs. inferential) among the participants, particularly the relative importance of semantic network knowledge for inferential comprehension. Multiple regression analyses showed that both syntactic and semantic network knowledge significantly predicted reading comprehension disregarding the type of comprehension, after controlling for working memory and vocabulary knowledge/size. As opposed to semantic network knowledge, syntactic knowledge was a significant, unique predictor of literal comprehension. In contrast, a converse pattern was found for inferential comprehension.

This thesis makes several significant recommendations and implications for improving the policy and practice of teaching and learning reading skills for policymakers, teachers, and researchers. It also sets out some directions for future research to further understand the lower-level L2 reading comprehension processes and their underlying aspects of knowledge and processing skills.

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List of the Abbreviations and Acronyms

No.	Acronym	What does it stand for
1.	L2	Second language
2.	L1	First language
3.	EFL	English as a Foreign Language
4.	ESL	English as a Second Language
5.	ELT	English language teaching
6.	EMI	English as a medium of instruction
7.	GPA	grade point average
8.	NGOs	non-governmental organizations
9.	MoE	Ministry of Education
10.	BERA	British Educational Research Association
11.	VLT	Vocabulary Levels Test
12.	WAT	Word Association Task
13.	RTs	The reaction times
14.	IES	inverse efficiency score

Chapter 1. Introduction

This doctoral thesis investigates the lower-level processes of second language (L2) reading comprehension with a focus on the roles of linguistic knowledge and processing skills in Arabic-speaking learners of English as a Foreign Language (EFL). The purpose of this chapter is to introduce the topic of the research and to state the research problem, which was addressed through two studies distinct in terms of focus. It begins by setting out the general aims of the thesis and the specific aims of each study, together with the significant contributions made by this research to the field. It subsequently presents an overview of the research context, namely EFL in Saudi higher education institutions. The chapter ends by setting out the overall structure of the rest of the thesis.

1.1 Overview

Reading is an essential skill for achieving success in education and subsequently in one's career. It is not only an important target for learning one's first language (L1), as well as a second language (L2) or additional languages, but also plays a crucial role in learning in general (i.e. reading to learn) (Koda & Yamashita, 2018). It is widely recognised that comprehension is a fundamental goal of reading and a general expectation of everyone in developing reading proficiency (Grabe, 2009). Successful comprehension during reading involves the orchestration of a set of processes (Grabe, 2009; Koda, 2005; Perfetti, Landi & Oakhill, 2005; Urquhart & Weir, 1998), which can be broadly classified into lower-level and higher-level functions. These processes operate at the same time and interact with each other in the construction of textual meaning (Grabe, 2009; Grabe & Stoller, 2019; Just & Carpenter, 1980; Kintsch, 1988; Perfetti, 1985; Perfetti & Adlof, 2012; Perfetti et al., 2005).

Lower-level processes of reading present the foundations of comprehension. Textual comprehension will be hampered if these lower-level processes do not function properly and rapidly (Crain & Shankweiler, 1990; Grabe, 2009; Just & Carpenter, 1992; Perfetti, 1985). Most prominently, they include word recognition and word-to-text integration (Fender, 2001). Each process requires distinct linguistic knowledge (e.g., sub-lexical, lexical, semantic network and syntactic); however, linguistic knowledge in itself is insufficient. Because working memory is a system with limited capacity (Just & Carpenter, 1992), efficient access to or retrieval of such knowledge

is also fundamentally important. In other words, to comprehend a text, a reader needs not only knowledge at different linguistic levels, but also efficient linguistic processing (i.e., automaticity).

To begin with, a reader must recognize the words of a text accurately and rapidly by activating links between a word's orthographic form and its meaning (Grabe, 2009). This word recognition process is considered to be the first critical process in reading comprehension (be it in L1 or L2), and all other processes of reading comprehension depend on it (Just & Carpenter, 1980; Kintsch, 1998; Oakhill & Cain, 2012; Perfetti, 1985; Perfetti & Adlof, 2012; Snowling & Hulme, 2005). Word recognition involves simultaneous and skilful execution of a set of sub-lexical and lexical elements, such as phonological, orthographic, morphological and semantic processes. The Lexical Quality Hypothesis (Perfetti, 2007) contends that lexical representations involve four constituent features of word identity: orthography, phonology, semantics and morphosyntax. High-quality (sub-)lexical representations facilitate rapid recognition of words – and also the integration of words into a mental model of the text– (Perfetti, 2007; Perfetti & Stafura, 2014) and are thus fundamental for smooth reading comprehension.

The next crucial process for reading comprehension is word-to-text integration, which is an ongoing process in which the meanings of individual words are continuously combined into larger units of meaning at the phrase, clause and sentence levels and beyond (Fender, 2001; Perfetti & Stafura, 2014). Some sub-processes are essential for word-to-text integration, notably syntactic parsing and semantic association/inferencing, which respectively require syntactic knowledge and semantic network knowledge, as well as efficient syntactic and semantic processing skills (Muter, Hulme, Snowling & Stevenson, 2004). In other words, like word recognition, word-to-text integration also relies on some aspects of linguistic knowledge and processing skills for proper execution, meaning that these aspects of knowledge and skills (e.g. syntactic knowledge and processing) all contribute to successful reading comprehension.

In summary, the recognition of individual words without the ability to integrate them efficiently when reading a text could negatively affect the reader's understanding of that text (Fender, 2001; Grabe, 2009; Perfetti & Stafura, 2014, 2015; Raudszus,

Segers & Verhoeven, 2018). In turn, the word-to-text integration process is not possible without efficient word recognition because well-defined lexical representations that can be accessed speedily facilitate word-to-text integration (Raudszus et al., 2018). Each aspect – recognition and integration – requires distinct aspects of linguistic knowledge and skills, and the smooth operation of these two lower-level processes then frees up cognitive resources for higher-level processes, undergirding successful textual comprehension (Grabe, 2009; Perfetti, 1985, 1988, 2007; Perfetti & Hart, 2001; Perfetti & Roth, 1981; Stanovich, 1980, 2000).

1.2 Statement of the Problem

The problem that motivated this research is that there is still much to be understood about the role of diverse aspects of linguistic knowledge and skills in supporting reading comprehension, from sub-lexical to lexical and syntactic, in L2 reading comprehension, particularly among adult Arabic-speaking readers of English. To highlight, studies of L2 reading comprehension have focused largely on aspects of linguistic knowledge, such as vocabulary knowledge/size and grammatical knowledge, and more recently morphological knowledge/awareness (see Jeon & Yamashita, 2014). Little research has considered the efficiency of linguistic processing efficiency, such as sub-lexical/morphological processing, and the distinct contributions linguistic knowledge and processing efficiency may make to L2 reading comprehension.

Moreover, in the L2 reading literature, even though the importance of the word-to-text integration process has been emphasized in relation to comprehension, less attention has been paid to semantic association/compared to syntactic parsing (Fender, 2001; Grabe, 2005). Although L2 reading researchers have explored vocabulary depth, sometimes in comparison to vocabulary size, in reading comprehension (e.g. Li & Kirby, 2014; Qian, 1998; Zhang, 2012), and the literature on vocabulary depth has considered semantic association (e.g. Read, 1998; Zhang & Koda, 2017), studies on vocabulary depth and L2 reading comprehension have often not been adequately theorized, particularly in light of recent theoretical insights into lexical quality and the importance of semantic processes for the generation of inference and inferential comprehension (Oakhill, 2020; Perfetti & Stafura, 2014, 2015). Little research has aimed to test how distinct aspects of knowledge underpinning word-to-text integration processes, such as semantic network knowledge versus syntactic knowledge, may be

differentially important depending on the type of L2 comprehension (i.e. literal and inferential).

Although a considerable body of research has examined the differences between readers and within a reader and how they might vary in contributing to comprehension in the L1 (RAND, 2002), limited research has been conducted with adult Arabic-speaking EFL readers. Various systematic reviews (e.g. Choi & Zhang, 2018; Shin, 2020) have shown that participants in previous studies have been from contexts different from that in this research, with the exception of Jeon and Yamashita (2014), who identified one study that involved Arabic-speaking EFL learners. Adult Arabic-speaking EFL readers are likely to face challenges over and above younger learners in achieving high literacy skills in English, because the texts such learners encounter in higher education often contain sophisticated vocabulary and complex linguistic and discourse structures (RAND, 2002). In addition, the L2 literature on adult foreign language learners has often focused on higher-level processes rather than lower-level processes, such as issues related to background knowledge (for exceptions, see Nassaji, 2003, 2014). Thus, examining lower-level processes of L2 reading comprehension of adult Arabic-speaking EFL readers could offer valuable insights, and it is of great importance to tackle related issues analytically when examining the role of diverse aspects of linguistic knowledge and processing skills in supporting L2 reading comprehension.

The choice of the research problem for this thesis was also motivated by my teaching experience. I had worked as an English language instructor and a lecturer in the Educational Studies department in a Saudi university for several years. Students at the university level in Saudi Arabia are required to have an advanced level of English language proficiency for them to succeed in English-Medium education. Strong English reading comprehension is fundamental to their disciplinary studies. Yet, to my knowledge and from my experience of teaching university Arabic-speaking students, reading in English language for academic purposes, including disciplinary texts, is not an easy task for most of them. Poor reading comprehension could negatively affect their academic progress. Practically speaking, it is thus of critical import to find out the sources of difficulties that prevent some students from developing good comprehension skills in English. Linguistic knowledge and skills are arguably critical

considerations and directed my interest to examine reading comprehension skill in English as a foreign language in those students.

1.3 Purpose of the Research

This thesis reports on two studies undertaken to address the aforementioned research gaps and generate new understandings concerning the complex linguistic processes underlying L2 reading comprehension. The participants comprised a group of Arabic-speaking EFL learners from a Saudi university, the same in both studies. A battery of paper-and-pencil and computer-based tests was administered to measure the participants' English reading comprehension, diverse aspects of English linguistic knowledge and processing efficiency, and working memory. Hierarchical regression analysis was conducted to examine how distinct linguistic knowledge and processing skills may uniquely and relatively predict reading comprehension, controlling for working memory.

Study 1 aimed to focus on the sub-lexical and lexical processes (underpinning word recognition) in L2 reading comprehension. The participants' sub-lexical/morphological knowledge (knowledge of word parts, such as derivational affixes) and lexical knowledge (knowledge pertaining to word form–meaning relationships, more commonly known as vocabulary size knowledge) were measured through a set of paper-based tasks. In addition, their morphological processing (morphological segmentation and combination) and lexical processing (lexical decision) skills were measured with computer-based decision tasks. This study examined how these distinct processes – knowledge vs. processing efficiency on the one hand and sub-lexical/morphological vs. lexical on the other – collectively and relatively predicted the participants' reading comprehension, after controlling for the effect of working memory.

Study 2 aimed to compare the two distinct components of the word-to-text integration process, that is syntactic parsing and semantic association, in L2 reading comprehension. The participants' syntactic knowledge (grammatical error correction) and semantic network knowledge (semantic association) were measured with paper-based tasks. The study assessed how syntactic and semantic network knowledge, controlling for working memory and vocabulary knowledge/size, differentially predicted two types of text comprehension (literal vs. inferential) among the participants,

particularly the relative importance of semantic network knowledge for inferential comprehension.

1.4 Significance of the Research

The research reported in the two studies is theoretically and pedagogically significant. Theoretically, it supports the proposition that L2 textual comprehension depends on the interplay of a lot of linguistic knowledge, as well as processing skills, from sub-lexical to lexical to syntactic, in light of their distinct contributions to lower-level processes, such as word recognition and word-to-text integration. Addressing some research gaps reflects the significance of the current research by specifically enriches current understandings in terms of linguistic knowledge being necessary but not sufficient for L2 reading comprehension and how the functioning of linguistic processes may be modulated by the type or goal of comprehension. The findings inform the construction of a more comprehensive and accurate reading comprehension model for L2 readers.

One of the key educational priorities of UNESCO, national states and many non-governmental organizations (NGOs) is to help individuals read and ensure literacy in populations around the world (Grabe, 2009). As a result, in any literacy research agenda, the ultimate aim tends to be to help learners read fluently and comprehend texts sufficiently well (RAND, 2002). This links to the key aim of this research, namely to improve learners' literacy by meticulously scrutinizing reading comprehension skills and ultimately disseminating the outcomes to learners, educators, policymakers and researchers. In other words, the importance of this thesis lies primarily in the intention to conduct rigorous research and contribute valuable insights that will add to the existing body of knowledge on lower-level processes of L2 reading comprehension and the underlying aspects of linguistic knowledge and processing skills with a view to aiding those in the field with an interest in improving literacy.

Although this research was not designed with any pedagogical focus, the findings will necessarily articulate to L2 educators the essential reading comprehension processes, particularly which components of linguistic knowledge and processing skills are more critical for L2 reading comprehension and should thus be prioritized in L2 reading pedagogy (e.g. semantic processes and inferential comprehension) among adult Arabic-speaking EFL learners. There is a widespread belief that proficient

reading in the L1 is a natural and inevitable outcome when good reading instruction is available. This could also be applicable to reading in an L2. However, there is not yet an adequate research base for designing and implementing effective reading comprehension instruction (RAND, 2002). Providing such a research base is essential to help literacy researchers, practitioners and policymakers develop an understanding of how to design effective means of instruction and foster reading comprehension in English, more specifically for adult EFL students who are required to be proficient readers at the higher education level.

Indeed, in the last couple of decades, researchers have argued that identifying reading processes is crucial to establish a practical framework for reading instruction (Koda, 2005; Perfetti et al., 2005). Examining the relative contribution of different aspects of linguistic knowledge and processing skills to reading comprehension generally and the various types could provide practical guidance for curricular design and instruction to address the developmental needs of L2 readers (Koda, 2007; Zhang, 2012). Furthermore, the results of this research will have implications for teaching and measuring reading comprehension skills, lexical knowledge and syntactic knowledge that will potentially be useful for educators and language teachers. As highlighted in Chapter 6, some aspects of linguistic knowledge and processing skills have not yet received much attention in L2 reading pedagogy, such as morphological processing efficiency, rapid recognition of morphologically complex words, semantic network knowledge/vocabulary depth and inferential comprehension.

1.5 Research Context

This section provides a brief introduction to the context in which the research took place. The study was conducted with first-year students at Taif University, one of the public higher education institutes in Saudi Arabia. At the time of the study, the students were all studying enrichment courses to develop their competence in English for academic purposes before transitioning to English-medium disciplinary studies (e.g. engineering) from the second year.

The education system in Saudi Arabia is divided into general education and higher education, which is predominantly funded by the Saudi government and overseen by the Saudi Ministry of Education (MoE). While private institutions also exist, they are far outnumbered by public schools, universities and institutes (MoE, 2020). Public

general education and higher education institutions are free for all students, including non-Saudis. The government provides an adequate pedagogical environment, facilities and school books, as well as free-of-charge transportation.

Before general education, there is pre-primary education, which is for children below six years of age and is not compulsory. Public schooling comprises three main tiers. The first tier is primary, which consists of six years of education, starting at the age of five years and six months or six years. Some children enrol in compulsory primary school aged six without undertaking pre-primary education. Intermediate education then lasts three years and is completed before enrolling in secondary education, which is the highest tier and also comprises three years of study. Completing these three levels is required for students wishing to apply for higher education.

Higher education in Saudi Arabia covers Bachelor, Master and Doctorate (PhD) degrees. Education at this stage in public institutions is free for citizens with a monthly stipend. According to recent reports by the MoE, in the last two decades, 30 public universities, 13 private universities and 42 private colleges have been founded throughout the country. This expansion was a consequence of the sustained efforts made by both the government and private sector to improve higher education in recent years (MoE, 2020). Students can apply to attend a university (public or private) based on the grade point average (GPA) they achieved at secondary school; they will also need to take placement tests, often administered by the university, for the specialty they wish to study. The typical age range of students applying to university is between 17 and 25 years old, with rare cases of students who are older than 25.

English is the only compulsory foreign language taught in Saudi public schools and higher education institutions. In Saudi general education, the age of starting English learning varies. Historically, formal English learning has typically commenced in the first grade of intermediate education, i.e. Grade 6, or at about the age of 12–13 years. However, this has changed in recent years due to the shift in policy toward offering English from as early as the fourth year of primary school (Grade 4 or at age 8–9).

English language learning continues from general education to higher education. Indeed, English language teaching (ELT) receives special attention in universities and colleges because English is generally the medium of instruction (EMI) in higher education institutions in Saudi Arabia, especially in science, engineering and medical

majors. The MoE has made several attempts to promote ELT and enhance Saudi undergraduates' English proficiency and prepare them for EMI disciplinary learning. A notable policy is that students in higher education institutions should attend English enrichment courses to develop their academic communication skills, including academic reading and writing, in the first year (this is also known as the foundation program).

Although ELT practices vary across higher education institutions, a recent study shows that the implementation of EMI in universities of Saudi Arabia may pose several challenges to both teachers and students due to the gap in terms of actual classroom practices, between EMI as an official language policy and Arabic as de facto medium of instruction (Louber & Troudi, 2019). In general, there is a strong focus on students' development of linguistic knowledge, particularly vocabulary and grammatical knowledge. AL-Nifayee (2010), for example, criticizes the reading activities in classes in Saudi universities because of their focus on grammar. While it is the case that linguistic knowledge, such as grammar and vocabulary (size), provides a critical underpinning for reading comprehension, a limited focus on other skills, particularly morphological processing and vocabulary depth, which are often not a focus of instruction in Saudi EFL classrooms, will hamper students' reading comprehension and consequently their opportunity to learn from reading.

At Taif University, where the participants were recruited, English is endorsed as a compulsory subject in all programs offered. There is an English Language Centre in the university, which has been established as a unit at the Deanship of Supportive Studies. It works in cooperation with various departments of the university to teach English language skills by offering a number of compulsory English courses for academic and special purposes in addition to a range of elective courses. These courses aim to prepare university students to undertake their studies through English-medium instruction in their different disciplines (Portal, 2021). First-year university students must go through a whole year (Foundation Year) in which they study English intensively, together with some other subjects, before proceeding to their disciplinary learning, which typically starts from the second year. As it is the case in many other universities in Saudi Arabia, the intensive English courses are designed to prepare students for their disciplinary studies and enhance their English language proficiency for certain university majors, especially those that require extensive use of English.

English for Academic Purposes (i.e. academic English language courses) and English for Specific Purposes (i.e. specific courses in English language for different specializations) are also offered for students of some majors in addition to the intensive general English language courses.

In the English Language Centre, teachers have access to various continuing professional development (CPD) opportunities and opportunities to provide input on methodologies of teaching different language skills; reading skills are no exception. A professional development program has been in place for faculty members to exchange their teaching expertise and experiences at the end of each semester. Furthermore, in partnership with Cambridge University, workshops and Train the Trainer program are offered for faculty members to further develop their skills in English language teaching (Portal, 2021). Nevertheless, formal CPD events that specifically target lower-level processes of reading comprehension, the focus of this thesis, are rare.

1.6 Research Questions and Variables

This research project aimed to answer six research questions through two distinct studies. Each study addressed three questions and had reading comprehension as the dependent/criterion variable and distinct linguistic knowledge and skills as the independent variables or predictors. In both studies, working memory was also included as a control variable. Specifically, in Study 1, the dependent variable was reading comprehension, and the independent variables were lexical knowledge, sub-lexical knowledge, lexical processing, and sub-lexical processing. The research questions for study 1 are as follows:

1. How do lexical vs. sub-lexical knowledge on the one hand, and lexical vs. sub-lexical processing efficiency on the other, relatively predict L2 reading comprehension? How do lexical-level competence (knowledge and processing efficiency) vs. sub-lexical competence (knowledge and processing efficiency) relatively predict L2 reading comprehension?

2. How do lexical knowledge vs. processing efficiency on the one hand, and sub-lexical knowledge vs. processing efficiency on the other, relatively predict L2 reading comprehension? How does knowledge (lexical and sub-lexical) vs. processing efficiency (lexical and sub-lexical) relatively predict L2 reading comprehension?

3. How do the four lexical competences – lexical and sub-lexical on the one hand and knowledge and processing efficiency on the other – collectively and relatively predict L2 reading comprehension?

The dependent variables of study 2 were reading comprehension and its sub-types including literal and inferential comprehension. The independent variables were semantic network knowledge and syntactic knowledge, in addition to working memory and vocabulary size as control variables. The research questions addressed in study 2 are as follows:

1. Do syntactic knowledge and semantic network knowledge, which respectively underpin the syntactic and semantic processes of word-to-text integration, uniquely predict reading comprehension in adult L2 readers of English?

2. How do syntactic knowledge and semantic network knowledge differently predict literal comprehension?

3. How do syntactic knowledge and semantic network knowledge differently predict inferential comprehension?

1.7 Thesis Structure

The remainder of the thesis is structured as follows:

Chapter 2 presents a critical discussion of the relevant literature on the essential components of this thesis: the complexity of reading comprehension and its lower-level processes, more precisely word recognition and word-to-text integration processes and the underpinning linguistic knowledge and processing skills. It also describes how this research broadly relates to some known theories or models of lower-level reading comprehension processes and how it builds upon and extends the existing work on L2 reading comprehension.

Chapter 3 presents the methodology and methods of this research. It begins with a discussion of the positivist stance underlying the research, followed by a detailed account of the participants, together with the research methodology and design. It then describes the data collection instruments and procedures and discusses issues of data validity and reliability. This chapter ends with a discussion of some ethical considerations that were scrupulously addressed.

Chapter 4 presents study 1, which investigated the lexical basis of L2 reading comprehension with a focus on how sub-lexical/morphological and lexical knowledge, as well as processing efficiency at these two levels, collectively and relatively predicted comprehension, controlling for working memory. The chapter describes the theoretical framework of the study and reviews relevant literature. The methods of data collection and analysis used in the study are introduced. This is followed by a comprehensive report of the results, supported with tables of results. It also includes a detailed discussion of the key findings in relation to the literature.

Chapter 5 presents study 2 of this thesis, which focused on the underlying linguistic knowledge related to two components of the word-to-text integration process, namely grammatical knowledge (syntactic parsing) and semantic network knowledge (semantic association). In particular, the study assessed how syntactic and semantic network knowledge, controlling for working memory and vocabulary size/knowledge, differentially predicted two types of text comprehension (literal vs. inferential) in L2 readers. It begins with a critical discussion of the relevant literature, followed by a description of the research methods in terms of data collection and analysis. The main results of the study are then reported and discussed the findings in link to the literature.

Chapter 6 provides an in-depth general discussion of the findings of the two studies, in light of the complex interplay of the diverse linguistic processes involved in L2 reading comprehension. It also discusses the research implications and limitations. It concludes by highlighting possible directions for future research. In particular, it underscores a need for longitudinal research to explore developmental reciprocity between linguistic knowledge and skills and reading comprehension in L2 readers.

Chapter 2. Literature Review

This chapter provides a general review of the relevant literature, defining and discussing the key constructs of the research and critically reviewing the results of studies related to the research variables (further critical reviews are presented in Chapters 4 and 5 to frame the two studies reported there). The primary focus of this chapter is on broadly reviewing the lower-level processes of reading comprehension, namely word recognition and word-to-text integration, as well as the different aspects of linguistic knowledge that underpin reading comprehension processes, specifically sub-lexical, lexical, the semantic network and syntactic knowledge, and associated processing skills. The chapter outlines the role of working memory in the lower-level processes of reading comprehension and different types of reading comprehension. Exploring these concepts is fundamental, both in terms of providing theoretical background for the research and informing the choice of methods of inquiry and analysis. This review also aims to reveal research gaps in the literature, some of which have been addressed in the two studies conducted in this research. Finally, this chapter concludes by setting out the research questions.

2.1 The Nature and Complexity of Reading Comprehension

Reading comprehension, be it in the L1 or an L2, is an important skill. Indeed, it is considered one of the essential skills for learning (Koda & Yamashita, 2018). In academic settings, there are different reading purposes, for example reading to search for information, reading to gain understanding and reading to learn (Harmer, 2001). Developing skilled readers with high levels of proficiency in literacy, able to learn optimally from reading texts, is a primary goal of language educators. This raises an important question in terms of what reading comprehension is and thus its nature is thoroughly examined in the following paragraphs.

Reading comprehension has been widely conceptualized in the literacy research field as a convoluted process. For example, the RAND Reading Group (2002) defined comprehension and discussed its complexity, considering it to be a constructive process that involves simultaneously extracting and constructing meaning through interaction and involvement with a written text. Later and in line with this view, Zhang (2012) described reading comprehension as the continual extraction and incremental integration of textual information. More importantly, Grabe (2009) further asserted that reading is not a single process, but a complex constellation of linguistic, learning,

interactive and rapid processes. Reading as a linguistic process means that understanding a text requires the reader to have adequate knowledge of the language in which it is written (Perfetti et al., 2005). Reading as a learning process refers to the logical outcome of reading, which is learning. Reading as an interactive process refers to how reading brings into play the writer's message and the reader's background knowledge and his/her personal interpretation of the text (Breznitz, 2006). Finally, reading as a quick and automatic process refers to the ability of skilled readers to read fluently and accurately and subsequently efficiently comprehend a text. On average, fluent readers can achieve a rate of about 250–300 words per minute for most of the materials they read (Pressley & Fingeret, 2006). In addition, learning to read well or to be a skilled reader is a long-term developmental process (RAND, 2002).

The Interactive–Compensatory Model (Stanovich, 1980, 2000) construes reading comprehension as a multi-component process comprising multiple cognitive processes and involving separate reading subskills. In the context of L2 reading, Koda (1996, 2005), Grabe (2009) and Bernhardt (2010) all similarly define reading comprehension as a multi-component process. This is also in line with Perfetti and Adlof's (2012) statement that reading comprehension is not uni-dimensional, but entails cognitive processes that operate on many kinds of knowledge to achieve many kinds of reading tasks. Moreover, Grabe (2014) argues that a reader needs a range of knowledge, skills and strategies, including word recognition and linguistic knowledge for example, to cope with diverse reading purposes or activities. These multiple-factor interactions between several components result in the development of reading comprehension as each component plays a significant role in the reading process (Choi & Zhang, 2018).

In association to the elements in the reading comprehension process, the RAND Reading Group (2002) introduced a heuristic that postulates the elements of the reading process itself: the reader, the text and the activity. These three elements interact in dynamic ways and they occur within a broad social and cultural context that encompasses diverse social practices and learning theories (see Figure 2.1). The reader has all the capacities, abilities, knowledge and experiences that will be brought to the act of reading (RAND, 2002). These qualities vary considerably among readers (i.e. inter-individual differences) and vary even within an individual reader as a function of the particular text and activity (i.e. intra-individual differences) (RAND, 2002). In the

Construction–Integration Model (Kintsch, 1988, 1998), the reader's cognitive architecture and cognitive procedures, as well as textual devices, influence comprehension.

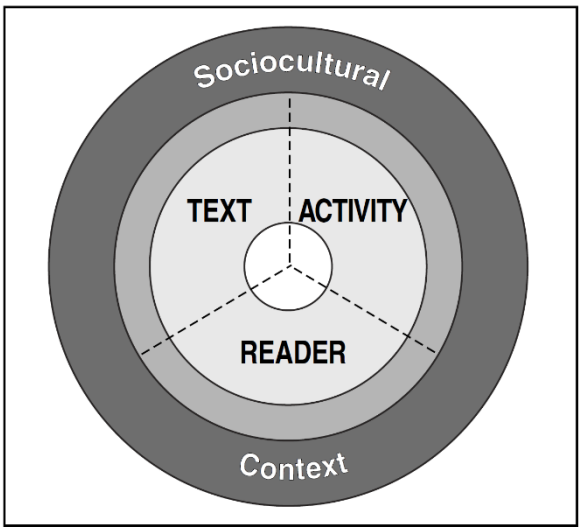

Figure 2.1. Heuristic for reading comprehension (source: adopted from RAND Group, 2002, p. xiv).

This leads to the second element – the text – whether printed or electronic. Texts are also of different genres, such as expository, narrative, descriptive, or persuasive. Texts in different genres vary in their level of complexity, consequently presenting different challenges for different readers due to their various linguistic characteristics, such as lexical, grammatical and discoursal. In other words, the reader's textual understanding of different text types can vary because of the different textual demands, including the linguistic processes involved. This issue adds another layer of complexity to reading comprehension and to its underlying processes.

Finally, the third element – the reading activity – includes the purposes, processes and consequences that are associated with the act of reading, which can also manifest readers' intra-individual differences (RAND, 2002). The act of reading as summarized in the Text Base Model (Van Dijk & Kintsch, 1983) starts with a reader, who when reading accesses different word meanings, integrating pieces of semantic and syntactic information, and builds local and global coherence. The reader then connects and integrates information from the text with his/her relevant prior knowledge to allow deeper comprehension (Van Dijk & Kintsch, 1983). Thus, different reading activities or purposes clearly affect the reader's engagement and interaction with the text.

Another issue regarding the activity element of reading is that reading comprehension involves different types, notably literal or explicit versus inferential or implicit. This distinction has long been recognized as the distinction between reading the lines, reading between the lines and reading beyond the lines, as suggested by Gray in 1960. The first, basic level of reading comprehension entails literal understanding, which is based on understanding an explicitly stated proposition or identifying the relationships between explicit propositions (Alderson, 2000; Alptekin & Ercetin, 2010, 2011). This level of textual comprehension can be derived directly from the text. In contrast, textually implicit comprehension, the second type of comprehension and the one more challenging for the reader, entails inferential comprehension. Inferential comprehension relies on the reader's ability to make either connective or elaborative inferences (Alptekin & Ercetin, 2010, 2011). Making connective and elaborative inferences requires the reader to have and access different kinds of knowledge. For example, in the case of connective inferences, readers are required to integrate implicitly presented textual information and schematic knowledge, which involves implicit processing for local coherence, whereas in making elaborative inferences, readers are required to draw inferences by moving beyond the text to construct a mental model of what it is about, which involves implicit processing for global coherence (Alptekin & Ercetin, 2009). These different types of comprehension may all require the basic processes, including linguistic processes. However, how these processes are executed, or their relative importance may vary depending on the type of comprehension.

To sum up, reading comprehension is a complex process which involves three key components, namely the reader, the text and the activity. Reading comprehension involves diverse processes, further reviewed in section 2.3. The level of accuracy and fluency of the operationalization of these processes will vary across readers, texts and reading purposes/activities. Put another way, readers orchestrate processes differently to cope with different texts and for different types of comprehension.

2.2 Reading Comprehension Processes

Reading comprehension requires the orchestration or simultaneous execution of a number of processes (Cain & Barnes, 2017; Perfetti, 1999). These can broadly be classified into lower-level processes and higher-level processes. Comprehending a text involves a combination of lower-level or bottom-up processes and higher-level or

top-down processes (Just & Carpenter, 1980; Perfetti, 1985). Specifically, according to the Construction–Integration Model of reading, an interactive combination of top-down, knowledge-driven processes and bottom-up, word-based processes is critical for successful reading comprehension (Kintsch, 1988, 1998).

Another dominant model of reading, the Reading Systems Framework, developed by Perfetti (1999) (see also Perfetti & Stafura, 2014), suggests that understanding in the reading process requires adding word-level processes to the higher-level processes (see Figure 2.2). In the Reading Systems Framework, the processes of reading include decoding, word identification, meaning retrieval, constituent building (sentence parsing), inferencing and comprehension monitoring. It shares with the Construction–Integration Model consideration of the same processes and also general consideration of the bidirectional association between most processes. In agreement with this, other key literacy researchers have confirmed that an interaction between the lower-order or lower-level or word-based processes and higher-order or higher-level processes is crucial for successful reading comprehension (Grabe, 2009; Grabe & Stoller, 2019; Just & Carpenter, 1980; Perfetti, 1985; Perfetti & Adlof, 2012; Perfetti et al., 2005). Accordingly, this research utilized the componential or component skills approach because it aims to examine reading by identifying the component processes and by modelling how these processes interact to predict/influence comprehension (Carr, Brown, Vavrus & Evans, 1990). Each of these reading processes must compete for the limited cognitive resources available in the working memory (Crain & Shankweiler, 1990; Gibson, 1998; Just & Carpenter, 1992). It is thus important for researchers examining reading to understand how these processes operate in tandem, within a limited capacity system, to result in smooth and efficient comprehension.

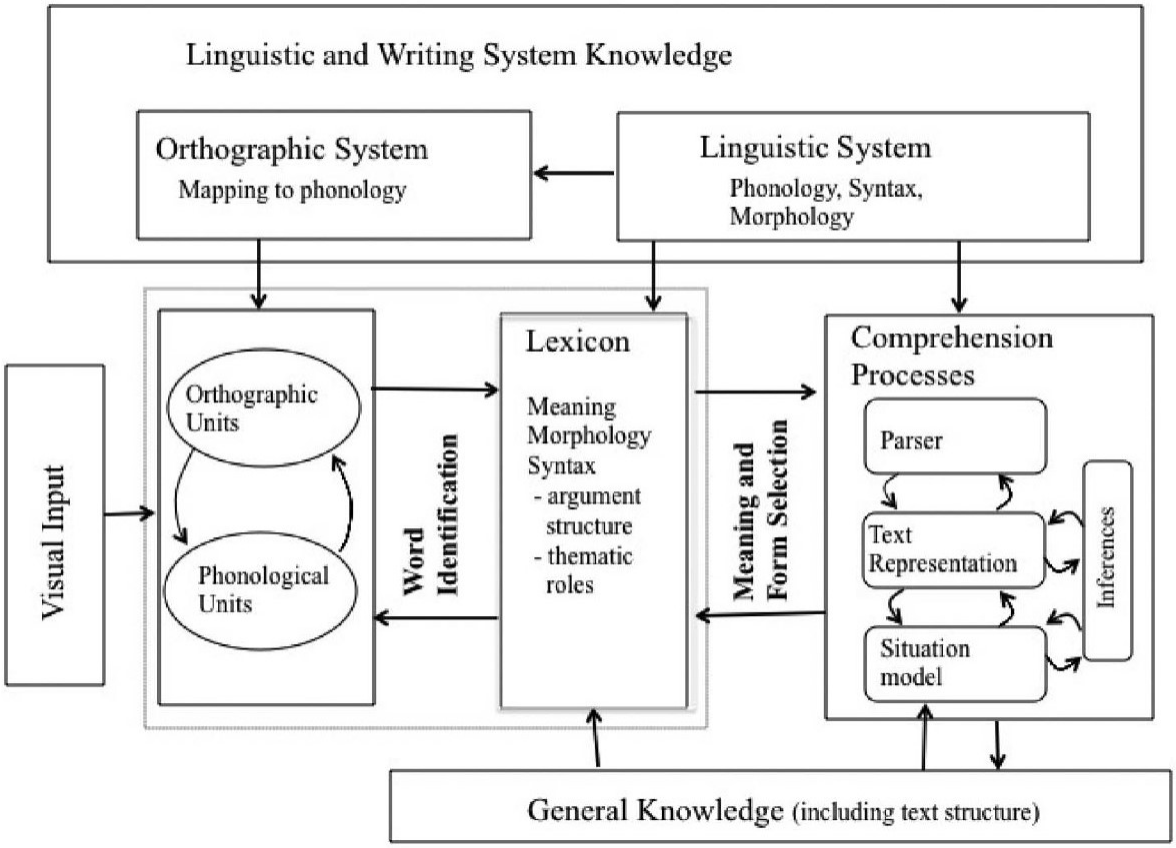

Figure 2.2. The Reading Systems Framework (adopted from Perfetti, 1999, p. 169).

According to Grabe (2009), higher-level processes of reading comprehension include a text model of reader comprehension, a situational model of reader interpretation and the use of reading skills and resources. While higher-level processes are important for L2 text comprehension, lower-level processes are fundamental, but have generally been under-researched in the EFL reading literature. Thus, this thesis chooses to focus on lower-level processes, with a specific emphasis on the underlying linguistic processes, i.e. word recognition (see 2.3.1) and word-to-text integration (see 2.3.2), addressed respectively in two studies emphasizing the linguistic knowledge aspects and processing skills.

2.3 Lower-Level Processes of Reading Comprehension

Lower-level, bottom-up, or word-based processes of reading comprehension involve some cognitive processes, particularly word recognition and word-to-text integration (Fender, 2001). The smooth operation of those two processes is essential to ensure an adequate level of reading comprehension (Grabe, 2009). According to the Verbal Efficiency Model (Perfetti, 1988), the efficient performance of lower-level processes frees up cognitive resources for higher-level processes. In other words, more textual

information can be processed and integrated in the working memory when lower-level processing skills, such as word recognition and word-to-text integration, are automatized (Crain & Shankweiler, 1990; Just & Carpenter, 1992; Perfetti, 1985). Furthermore, a lack of automatized lower-level processes will constrain the participation of higher-order processes such as textual inferencing in the effective construction of a mental model. This highlights the importance of lower-level processes for reading comprehension and how textual comprehension will be hampered if they do not function accurately and rapidly.

The reader processes letters/phonemes, words, clauses, sentences, local cohesion, and topic, pragmatic and discourse structure information to interpret and comprehend texts (Just & Carpenter, 1980; Perfetti, 1985). As a result, comprehension is an ongoing process that entails constructing propositional meanings while reading a text by integrating words into larger units of meaning at the phrase and clause levels (Fender, 2001; Perfetti & Stafura, 2014). These processes use knowledge sources in both constrained and interactive ways; to illustrate the former, decoding uses orthographic and phonological knowledge but not general knowledge, whereas in the latter, inferences use general knowledge and propositional meaning extracted from sentences (see Figure 2.4). Accordingly, to construct textual meaning, both linguistic knowledge and processing skills are essential (Grabe, 2009; Koda, 2005; Perfetti et al., 2005).

The connection between lower-level processes, word recognition and word-to-text integration, can be depicted by combining two well-known systems of reading comprehension, namely the Text Base Model and the Situation Model, as the reader first recognizes words, retrieves their contextually appropriate meanings and builds phrases (parsing) from words (Perfetti & Stafura, 2014; see Figure 2.3). The word recognition process is based on certain (sub-)lexical competences, such as phonological, orthographical, morphological and semantic knowledge, and the corresponding processing skills. In contrast, the word-to-text integration process draws heavily upon syntactic and semantic network knowledge and associated processing skills.

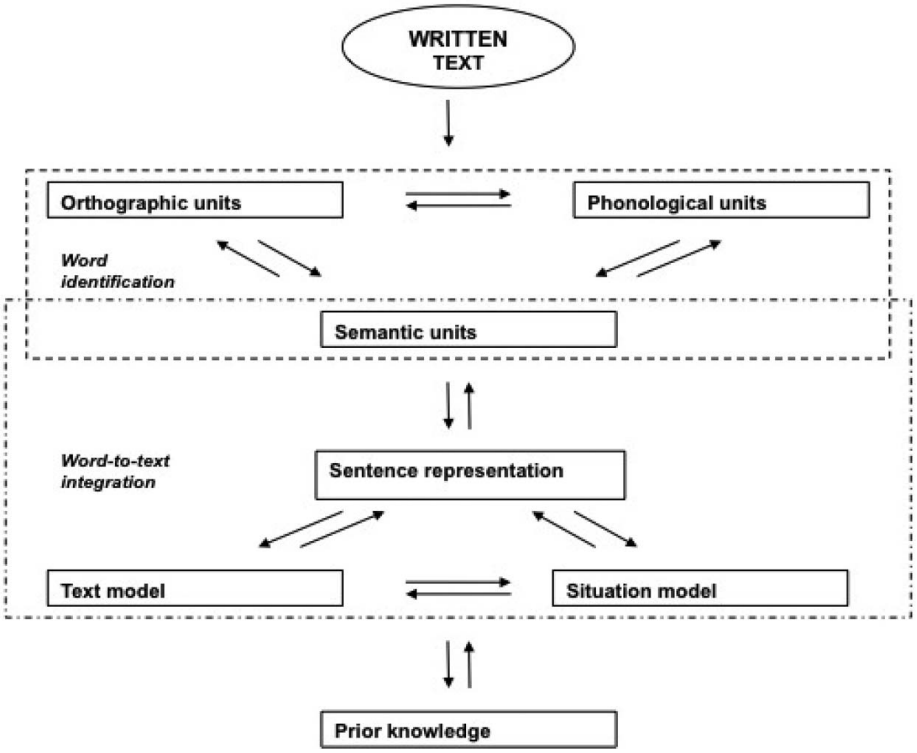

Figure 2.3. The connection between two reading comprehension systems (source: adopted from Perfetti & Stafura, 2014, p.33).

2.3.1 Word Recognition Process

The word recognition or identification process is one of the lower-level processes in textual comprehension (Hannon & Daneman, 2001; Perfetti, 1999, 2007; Perfetti et al., 2005; Raudszus et al., 2018). It is a recurring cognitive activity that takes place when reading (Grabe, 2009). Theoretically, word recognition is a critical first component of reading comprehension (Just & Carpenter, 1980; Kintsch, 1998; Oakhill & Cain, 2012; Perfetti, 1985; Perfetti & Adlof, 2012). In the Text Base Model, reading comprehension starts with the word identification process (Kintsch, 1998), as previously mentioned. Individual word recognition serves as input for the integration process, first at the sentence level and subsequently at textual level (Hagoort, 2013; Perfetti & Stafura, 2014). The Simple View of Reading also postulates that accurate recognition of words is essential for effective reading comprehension (Hoover & Gough, 1990). Although word recognition is not the only process crucial for reading comprehension, it frequently predicts the level of comprehension among both L1 and L2 readers, as found in many studies (e.g. Cain & Oakhill, 2014; Carrell & Grabe, 2002; Li & Kirby, 2014; Melby-Lervåg & Lervåg, 2014; Oakhill & Cain, 2012; Ouellette, 2006; Tannenbaum, Torgesen, & Wagner, 2006; Zhang, 2012). The findings of such

research add to the large body of evidence that reading comprehension depends primarily on the domain of word recognition.

The word recognition process has been conceptualized differently in the literature. For example, it has been described as "the ability to identify the printed form of a word or lexical item in order to retrieve the word's syntactic (e.g., part of speech), semantic (e.g., conceptual meaning), and pragmatic information (e.g., world knowledge associations)" (Fender, 2001, p. 320). Other researchers have argued that word recognition involves the interaction of activated orthographic, phonological, and semantic and syntactic processes (Perfetti, 2007; Perfetti & Hart, 2001). Similarly, Grabe (2009) stated that for fluent word recognition to occur, a reader must recognize the word forms on the page rapidly by activating links between the graphic form and phonological information, activating appropriate semantic and syntactic resources, recognizing morphological affixation in more complex word forms, and accessing the mental lexicon. Therefore, to achieve word recognition successfully when reading a text, the reader needs some lexical competences.

The Lexical Quality Hypothesis places lexical representations and processes at the centre of the Reading Systems Framework (Perfetti & Stafura, 2014) and posits that high-quality lexical representations are fundamental for textual comprehension (Perfetti, 2007). These representations involve the features of four constituents of word identity: orthography, phonology, semantics and morphosyntax (Perfetti, 2007). Together, the quality of these four features and the coherence among them facilitate rapid, low-resource retrieval of lexical word identities and their integration in a mental model of the text (Perfetti, 2007; Perfetti & Stafura, 2014). This theoretical insight demonstrates the importance of these four constituents for efficient word recognition, a process that is supported by a number of skills representing different lexical competences related to lexical/vocabulary knowledge (i.e. form–meaning connection) and sub-lexical knowledge (i.e. phonological, orthographic and morphological).

Lexical Knowledge. Lexical-level knowledge primarily concerns a form–meaning connection that is widely known in the literature as vocabulary size or breadth. It entails a single representation for a given item and it is not sensitive to the effects of context or any other factors (Cremer & Schoonen, 2013; Proctor, Silverman, Harring & Montecillo, 2012). The ability to link an individual word with its meaning has

theoretically and empirically received considerable attention in the literature due to its unquestionable importance for reading comprehension (Alderson, 2005; Grabe, 2009; Stanovich, 2000; Stæhr, 2008). Theoretically, in the Instrumentalist Hypothesis, words are the building blocks of a language and the reader needs to know their meanings in a text to comprehend it (Anderson & Freebody, 1981).

Empirically, a substantial body of research evidence has suggested there is a strong relationship between lexical knowledge and reading comprehension among both L1 and L2 readers (e.g. Droop & Verhoeven, 2003; Hutchinson, Whiteley, Smith & Connors, 2003; Proctor et al., 2005; Tannenbaum et al., 2006). Other prior studies have revealed that a lower level of L2 lexical knowledge results in problems in L2 reading comprehension (e.g. Burgoyne, Kelly, Whiteley & Spooner, 2009; Cremer & Schoonen, 2013; Grabe, 2009; Lervag & Aukrust, 2010; Proctor et al., 2012; Qian, 2002; Qian & Schedl, 2004). For instance, Cremer and Schoonen (2013) reported that delays in lexical knowledge run parallel to delays in reading comprehension. L2 researchers have found that vocabulary breadth is positively correlated with reading comprehension and it has been found to be a unique predictor of reading comprehension (Alderson, 2005; Jeon & Yamashita, 2014; Jiang & Grabe, 2011; Laufer, 1992, 1996; Li & Kirby, 2015; Nation, 2001; Qian, 2002; Read, 2000).

Sub-Lexical Knowledge. Sub-lexical knowledge entails three of the four constituents of word identity, namely orthography, phonology and morphology. These three constituents represent the intra-lexical knowledge that is related to an individual word: its orthographic, phonological and morphological features. Each aspect plays a unique role in word recognition and consequently reading comprehension.

First, orthographic knowledge concerns sensitivity to written letter patterns (Deacon, 2012), or rather to the orthographic structure of words (Georgiou, Parrila, Kirby & Stephenson, 2008). It consists of two components, word-specific knowledge, i.e. the spelling of specific words, and general orthographic knowledge, i.e. the conventional letter patterns of a writing system in a language (Zarić, Hasselhorn & Nagler, 2020). Theoretically, it is one of the key aspects of reading (Cunningham, Perry & Stanovich, 2001; Perfetti, 1985, 2007; Stanovich, 1980), and its significance is considered to be due to its direct relation to the visual word recognition process through lexical retrieval and thence to reading comprehension (Koda, Coady & Huckin, 1997). Orthographic

knowledge has been found in some studies to be a stronger predictor of L2 reading abilities among higher proficiency readers (Kato, 2009; Nassaji, 2003). Such evidence highlights the importance of incorporating spelling instruction and practice into reading instruction (Conrad, 2008). However, in a meta-analysis of L2 reading comprehension studies, this aspect of knowledge was found to have a low correlation with L2 reading comprehension among the other linguistic variables (Jeon & Yamashita, 2014).

Second, phonological knowledge concerns the reader's sensitivity to the segmentation, identification and manipulation of sound structures, such as phonemes, syllables, onset, coda, or rhyme (Jeon & Yamashita, 2014). Phonological knowledge is one of the major elements of the word recognition process. Some previous studies have confirmed empirically that the progress children make in learning to read is related to individual differences in their phonological skills (Bishop & Adams, 1990; Nation & Snowling, 2004). Nevertheless, it is well accepted that there is more to reading than decoding because readers need to comprehend what they have read (Nation & Snowling, 2004). Efficient word reading abilities are necessary but not sufficient for successful reading comprehension (Cain, Oakhill & Bryant, 2004). Furthermore, Kieffer and Leasaux (2008) have argued that this type of knowledge is unlikely to have a direct influence on reading comprehension. Again, in Jeon and Yamashita's (2014) meta-analysis, phonological knowledge was found, among the other linguistic variables, to present a low correlation with L2 reading comprehension.

The third constituent of high-quality lexical representations is knowledge of morphological features. Morphology is "the conventional system by which the smallest units of meaning, called morphemes (bases, prefixes, and suffixes) combine to form complex words" (Bowers, Kirby & Deacon, 2010, p.144). Morphological knowledge could contribute to textual comprehension, independent of lexical knowledge. The role of morphological knowledge in supporting word recognition has been highlighted theoretically, particularly in English texts, in which multimorphemic words are prevalent (Carlisle, 2003; Nagy & Anderson, 1984; Perfetti, 2007). Such knowledge has been underscored as an important constituent of the binding mechanism and morphological representations have considerable implications for learning to read (Bowers et al., 2010; Kirby & Bowers, 2017). In addition, Bowers et al. (2010) concluded that morphological instruction is particularly beneficial for less able readers and it is also

effective for younger students. (See Chapter 4, Study 1, which focuses on the unique contribution of morphological knowledge to reading comprehension.)

Processing Efficiency. As pointed out by Kintsch (1998), in attaining reading comprehension, some elements of fluency, including fluent word reading and fluent sentence reading, are involved. The Lexical Quality Hypothesis (Perfetti, 2007; Perfetti & Hart, 2001) posits that reading comprehension depends on the quality of word representations. Representations that are high in quality should be accessed effortlessly, which leaves more processing capacity (i.e. working memory; see 2.4) to be devoted to higher-level comprehension processes. Furthermore, high-quality representations of lexical and sub-lexical features are fundamental for the rapid recognition of printed words, which is an essential element of the reading comprehension process (Perfetti & Stafura, 2014). These theoretical insights signify the unique role of processing efficiency, in addition to the knowledge aspect, in word recognition and thus reading comprehension. This competence is interchangeably termed accessibility, automaticity, fluency, decoding and processing efficiency.

Cremer and Schoonen (2013) emphasized the importance of linguistic processing efficiency in light of the distinction between knowledge availability and accessibility. Knowledge availability refers to having the knowledge itself (e.g. knowledge of word parts), whereas accessibility refers to the capacity to have speedy and accurate recourse to that knowledge (e.g. morphological processing). The authors argue that the accessibility aspect of lexical knowledge supports reading comprehension as a separate, measurable component (Cremer & Schonnen, 2013). The availability aspect of lexical knowledge has been studied in previous research. In contrast, little research has been conducted on the accessibility of L2 lexical knowledge dimensions in relation to reading comprehension.

Processing skills have been measured in the literature in different ways. Segalowitz and Hulstijn (2005) state that measuring processing skills can solely be based on measuring recognition. This form of measurement has been used in many psycholinguistic studies, but mostly as part of the instruments used to understand the cognitive aspects of L1 or L2 language processing rather than for assessing vocabulary fluency per se (Zhang & Lu, 2014). Furthermore, Zhang and Lu (2014) argue that in the case of word recognition and meaning, one does not necessarily

require an awareness of the existence of the other. In another vein, some researchers have included meaning recognition in the measurement by assessing vocabulary fluency using the speed of meaning recognition (e.g. Cremer & Schonnen, 2013; Laufer & Nation, 2001; Zhang & Lu, 2014). This is based on the researchers' view that it constitutes a more informative measure than focusing on examining the speed of access of form recognition alone, as meaning recognition involves recognizing both form and meaning (Zhang & Lu, 2014). Other researchers have developed various measures to assess processing skills, for example an online version of the Word Part Levels Test (WPLT) developed by Webb and Sasao (2013) and the measure of lexical facility using response latency to measure lexical competence regarding individual words developed by Harrington (2018).

Put together, existing research argues that there are different dimensions of lexical competences underpinning efficient word recognition that are essential for reading comprehension. An aspect of interest lies in the interrelationships between these levels or dimensions and how they work together to influence reading comprehension. Exploring these could be a complex issue, especially when considering the roles of processing efficiency over and beyond the reader's knowledge of different aspects of lexis in developing reading comprehension.

First, concerning processing efficiency in relation to lexical knowledge, knowing a word not only entails the ability to recognize it and to access its meaning, but also the competence to do so within a fraction of a second (Nagy & Scott, 2000; Perfetti & Hart, 2002). A small number of studies, mostly among foreign language learners of English, have approached the issue of lexical processing efficiency in light of readers' rapid lexical decision. It has been hypothesized that readers who can access their lexical knowledge faster will also present better reading comprehension. In the L1 English reading literature, particularly in studies of school children or developing readers, sight word recognition efficiency and word decoding fluency have been found to be critical determinants of reading comprehension (Garcia & Cain, 2014). Theoretically, the significance of efficient lexical processing skills should not pertain only to L1 or monolingual readers. Indeed, word recognition efficiency, i.e. accurate and rapid recognition of printed words, has also been recognized as essential for L2 reading comprehension (Grabe, 2009; Koda, 2005).

Participants in most such studies were asked to perform simple decision tasks involving the recognition of word forms, for example determining whether an item was a real word or not (Zhang & Lu, 2014). Van Gelderen et al. (2004) measured the speed of word recognition among adolescent Dutch-speaking EFL readers using a lexical decision task which asked the learners to decide as fast as they could whether a letter string presented on a computer screen represented an existing word. The participants' reaction times (RTs) and accuracy of responses were both recorded, but no significant, unique effect was found for either on reading comprehension, when the effects of their metacognitive knowledge and linguistic knowledge were controlled for.

Some studies with young ESL learners or bilingual children, just like those with monolingual children, have considered the contribution of word decoding fluency to reading comprehension. Proctor, Carlo, August and Snow (2005), for example, found that after controlling for oral vocabulary, English decoding fluency was not a unique or significant predictor of fourth-grade Spanish-speaking ESL learners' reading comprehension in the United States (US). Yet, in Pasquarella, Gottardo and Grant's (2012) study, conducted with adolescent L2 readers of English in Canada, real and pseudoword decoding fluency, after controlling for vocabulary knowledge, significantly predicted reading comprehension. This issue warrants further empirical study using different measures of processing skills for lexical items. (See Chapter 4, Study 1, for more details).

Second, processing efficiency of different aspects of sub-lexical refers to less conscious or implicit processing of the constituents of lexical identity (orthographic, phonological and morphological information) (Perfetti, 2007). The Lexical Quality Hypothesis emphasizes the importance of high-quality representations of sub-lexical features because they are fundamental to the rapid recognition of printed words (Perfetti, 2007), as previously noted. A great deal is known about the factors supporting word recognition, which include phonological awareness, rapid automatized naming and orthographic processing (for a review, see the National Reading Panel [2000]). Morphological processing is a further factor in supporting efficient and accurate word recognition (Carlisle, 2003). The processing efficiency of these supporting components of sub-lexical knowledge is essential for word recognition and for smooth reading comprehension (Perfetti & Stafura, 2014). Empirically, compared to the L1 reading literature, there has been considerably less

research addressing fluency-related sub-lexical competences in the literature on L2 reading and such research as does exist has often approached the issue from diverse perspectives and has generated mixed findings.

In relation to the role of morphological processing in L2 reading comprehension, there is increasing research interest (e.g. Kieffer & Lesaux, 2008; Zhang, 2017; Zhang & Koda, 2012). Logic suggests that if morphological knowledge is important for lexical inferencing and/or word decoding fluency during text comprehension, as some L2 studies have suggested (e.g. Zhang, 2017; Zhang & Koda, 2012), access to this knowledge must be rapid for comprehension to be smooth and efficient. Zhang and Ke (2020) have stressed the importance of morphological decoding fluency in L2 reading comprehension. If efficient morphological processing, which entails quick access to morphological features such as morphological structure and the meanings of morphemic constituents, is not in place, fluent morphological decoding will not be possible. In other words, morphological knowledge is necessary but insufficient for efficient processing or recognition of multimorphemic words in print (for further details, see Chapter 4, Study 1).

2.3.2 Word-to-Text Integration Process

Important as individual word recognition is, in the absence of word-to-text integration, it will not aid comprehension (Raudszus et al., 2018). In other words, word recognition skills are necessary, but far from sufficient for reading comprehension because text comprehension not only depends on understanding the meanings of individual words but also on integrating their meanings into a mental model of the text. The meanings of single words must be integrated at the sentence and text levels for ongoing comprehension to be monitored (Willows & Ryan, 1986). Word-to-text integration has been found to distinguish more skilled comprehenders from less skilled comprehenders (Fender, 2001; Gough & Tunmer, 1986; Grabe, 2009; Perfetti & Stafura, 2014, 2015; Perfetti, Yang & Schmalhofer, 2008; Yang, Perfetti & Schmalhofer, 2005, 2007).

Nonetheless, the word-to-text integration process is not possible without efficient word recognition. Raudszus et al. (2018) stress that well-defined and speedily accessible lexical representations facilitate the word-to-text integration process. Sub-lexical and lexical knowledge feed into a unified system to arrive at word-to-text integration, which

in turn is the basis for textual understanding (Raudszus et al., 2018). In the Construction–Integration Model, the process of text comprehension requires the reader to integrate word meanings after accessing words to establish a text model and then to build a situation model through activation of background knowledge and various inferencing processes (Kintsch, 1988). This explains how reading comprehension could be achieved through word recognition and word-to-text integration.

The connection between word recognition and word-to-text integration can be depicted by combining two well-known systems of reading comprehension, the Text Base Model and the Situation Model, as the reader first recognizes words, then retrieves their context-appropriate meanings and builds phrases (parsing) from words (Perfetti & Stafura, 2014; see Figure 2.3). This is consistent with a neurobiological model of language processing suggested by Hagoort (2005), in which he asserted that a reader encounters a word (input from the visual orthographic system) that drives operations in the temporal lobes to retrieve associated linguistic and general knowledge from long-term memory.

The word-to-text integration process informs and constrains higher-level text comprehension processes that are involved in generating situation models or text bases, making elaborative inferences and generating complex logical entailments (Fender, 2001). This illustrates that the intricate relationship between the word-to-text integration process and the higher-level processes of reading comprehension, combining words together into larger structures, involves a range of complex and overlapping mental processes, such as syntactic parsing and semantic association. Syntactic parsing and semantic association processes are fundamental for building both local and global coherence and thus can affect text comprehension (Given, 1995; Zwaan & Rapp, 2006).

These two mental processes of word-to-text integration, syntactic parsing and semantic association, operate on certain aspects of linguistic knowledge, namely syntactic knowledge and semantic network knowledge, and processing skills. Sensitivity to the syntactic and semantic constraints of a language might be viewed as a resource that buttresses literacy development (Willows & Ryan, 1986). The word-to-text integration process is the ability to utilize the syntactic, semantic and pragmatic

information that is associated with individual words to then integrate them incrementally into larger phrase, sentence and discourse structures (Just & Carpenter, 1980). Muter et al. (2004) confirmed that syntactic knowledge and semantic network knowledge are important for reading comprehension. Furthermore, syntactic complexity and semantic ambiguity of sentences have been found to result in poor comprehension because language processing difficulties encompassing grammatical and semantic weaknesses predict poor reading comprehension (Nation & Snowling, 2000). Therefore, syntactic knowledge and semantic network knowledge underly the incremental integration of words into phrase and clause structures and their rapid interpretation.

The components of word-to-text integration (i.e. syntactic parsing and semantic association), based on the corresponding aspects of linguistic knowledge, could contribute differently to various reading tasks that are literal or inferential in nature. Literal comprehension, on the one hand, involves explicitly stated propositions in the text and could draw more on different degrees of linguistic knowledge rather than inferential understanding. Inferential understanding of a text, on the other hand, involves the readers' implicit proposition which draws on the ability to make either connective or elaborative inferences (Alptekin & Erçetin, 2009; Zhang & Yang, 2016). Generating inferences enables readers to move from the semantically "shallow" text base to the semantically "deep" situation model (Alptekin & Erçetin, 2010; Perfetti, 1999). The skill of making inferences is regarded as a central component in skilled reading (Garnham & Oakhill, 1996). Specifically, inferences are incorporated in the situation model as constructed by the comprehender and result in a more accurate and complete understanding of the text (Van Dijk & Kintsch, 1983). It is critical to understand that a text does not always explicitly state all of the information needed for coherence; thus, readers regularly make inferences to integrate information within the text and to fill in details that are only implicit (Currie & Cain, 2015). Therefore, these two distinct reading comprehension types demand different aspects of cognitive processing and linguistic knowledge (Zhang & Yang, 2016).

Syntactic Knowledge. Words are integrated into larger units of meaning, achieving syntactic parsing through syntactic knowledge. Syntactic knowledge is essential for word-to-text integration to establish propositional meanings that enable text model construction and integration (Fender, 2001; Kintsch, 1998). Extensive research has

shown that complex grammatical structures in a text increase the time needed for text processing (Fender, 2001), requiring a reader to have an adequate level of syntactic knowledge to process sentences easily while reading. Syntactic knowledge comprises knowledge of a variety of morphosyntactic properties, such as tense, word order, subject–verb agreement and articles (Jeon & Yamashita, 2014). Syntactic knowledge is likely to be a stepping-stone between vocabulary and reading comprehension (Raudszus et al., 2018; Zhang, 2012). Thus, syntactic knowledge could represent the basis for the parsing of recognized words in a text, resulting in understanding a proposition.

Syntactic integration using grammatical/syntactic knowledge leads to a better representation of the sentence, which in turn enables text comprehension (Grabe, 2005; Raudszus et al., 2018; Zhang, 2012). A developed level of syntactic knowledge enables readers to analyse and integrate syntactic information at the phrase, clause and sentence levels, which are crucial for achieving comprehension (Jeon & Yamashita, 2014; Raudszus et al., 2018; Zhang, 2012). It is also essential for coherence building (Givɛn, 1995). Overall, this emphasizes the significant role of syntactic knowledge in reading comprehension because it allows for syntactic parsing, which facilitates comprehension monitoring (Grabe, 2005).

Theoretically, there seems little doubt that syntactic knowledge is crucial for both L1 and L2 text comprehension (Alderson, 2000; Fender, 2001; Grabe, 2009; Gough & Tunmer, 1986; Perfetti, 1985). For example, the Simple View of Reading (SVR), proposed by Gough and Tunmer (1986), posited that the ability to comprehend what is read depends on both decoding and language comprehension. Language comprehension depends on both vocabulary knowledge and grammatical ability, among other things (Gough & Tunmer, 1986). In L2 reading research, Alderson (2000) suggests that “the ability to parse sentences into their correct syntactic structure appears to be an important element in the understanding text” (p. 37).

Most previous studies have empirically supported the importance of word-to-text integration using syntactic knowledge for parsing, not only for reading in the L1 but also in an L2. For example, Muter et al. (2004), in a longitudinal study conducted with children, found reading comprehension to be predicted by prior word recognition skills, vocabulary knowledge and grammatical skills. Muter et al. (2004) also suggested that

reading comprehension is more heavily dependent on syntactic language skills among adult readers. Proctor et al. (2012) investigated the unique contribution of syntax and found that it predicted English reading comprehension in English and Spanish–English speakers in the second to fourth grades, after controlling for vocabulary breadth. Adding to this, Farnia and Geva (2013) reported that in Grade 1, syntax is the most important positive predictor of the rate of growth in reading comprehension for both L1 and L2 readers. There is some evidence that poor reading comprehension is associated with syntactic difficulties (Muter et al., 2004; Nation & Snowling, 2000).

However, the central link between syntactic integration and text comprehension is under-investigated; not only have syntactic integration processes themselves received little attention, but also research on the role of syntactic integration in L2 reading comprehension is sparse (Raudszus et al., 2018). For example, when a measure of syntax is included in L2 research, it is often subsumed under a general language component (e.g. Babayiğit, 2015). Another concern is that in addition to syntax, vocabulary is not controlled for (e.g. Lesaux, Lipka & Siegel, 2006). Hence, the role played by syntactic knowledge in word-to-text integration in reading comprehension deserves further investigation over and above the role of word recognition.

Semantic Network Knowledge. The word-to-text integration process also involves making semantic associations using semantic network knowledge. Semantic network knowledge has been addressed in the L2 reading literature but in very diverse lines of work, such as vocabulary depth or word associates, semantic networks and lexical networks. For example, Read (2004), in his conceptualization of vocabulary depth, outlined three distinct but overlapping aspects of word knowledge in L2 vocabulary acquisition. One is network knowledge, which is about the incorporation of a word in a lexical network in the mental lexicon, together with the ability to link it to and distinguish it from related words (Read, 2004). Qian (1999, 2002) defines the depth of vocabulary as the degree to which lexical networks have been established, based on the perspectives of word meaning and collocation.

Theoretically, in the mental lexicon, lexical items are organized in a semantic network structure in which they are linked through various types of semantic relations (Aitchison, 2012). These semantic relations can be classified in terms of paradigmatic and syntagmatic distinctions. Words are paradigmatically associated when they form

semantic relations, such as synonyms or antonyms, and belong to the same word class (Zhang & Yang, 2016). Syntagmatic association pertains to a sequential relationship to the target word in a sentence and is usually a word from a different word class, namely collocation. Specifically, mastery of collocations seems to be robustly related to language proficiency (Schmitt, 2014).

Semantic network knowledge is essential for inferencing or making semantic associations within a text. Kintsch (1988) proposes that the activation of units connected due to semantic relatedness may facilitate the recognition of words and connecting them in propositions, as well as integrating overlapping propositions or those that are inferentially related. In this vein, Perfetti et al. (2008) also suggested that semantic network knowledge may be particularly important for inferences necessary for local coherence (i.e. those essential for adequate comprehension of the text) when a synonym, paraphrase, or category member refers back to an object mentioned earlier. Inferences for local coherence typically involve the integration of separate propositions within the text and are usually cued by a pronoun, synonym, or category exemplar (Currie & Cain, 2015). In other words, inferences for local coherence often require a mapping between related words, for example, between synonyms or category exemplar pairings (Cain & Oakhill, 2014; Currie & Cain, 2015). Thus, not only could knowledge of individual word meanings be important in making associations accurately and with ease, but also rich semantic networks with robust connections between the meanings of words associated by topic.

Research has already established that semantic network knowledge (i.e. depth, semantic associates or semantic relations) contributes significantly to – and indeed predicts – reading comprehension (Cain & Oakhill, 2012; Cremer & Schoonen, 2013; Ouellette, 2006; Roth, Speece & Cooper, 2002; Schoonen & Verhallen, 2008; Tannenbaum et al., 2006). For example, Ouellette (2006) found that the ability to produce synonyms, unique semantic features and category super-ordinates contributed to reading comprehension in monolingual children, even more so than vocabulary size. Cremer and Schoonen (2013) conducted a study with monolingual and bilingual participants aged 10–11 years, asking them to distinguish subordinates, super-ordinates, synonyms, meronyms and defining characteristics from contextually related distractor items. The children who were better at selecting the context-

independent related items also obtained higher reading scores, suggesting that these items may be particularly important for reading comprehension.

More prior studies show that integrating information between sentences to establish local coherence is crucial in understanding and making use of synonyms (Currie & Cain, 2015). For example, children who differ in reading comprehension skills also differ in their understanding and use of synonyms to integrate different propositions in a text (Cain & Nash, 2011). In addition, Currie and Cain (2015) found that poorer use of such signalling cues in children may be linked to limited inference for local coherence. This signifies the role of semantic network knowledge as a component of the word-to-text integration process in understanding local coherence or inferencing, and ultimately for successful text comprehension.

There are several challenges in terms of constructing measures of semantic network knowledge. For example, Webb and Sasoa (2013) argue that there are issues related to creating a test for collocational knowledge. They explain these issues by proposing some questions that should be considered, as follows: What is an effective test format that isolates knowledge of collocation? What criteria should be used to select collocations? How should frequency and part of speech be controlled? A measure commonly applied to assess the semantic relations between more than individual words is the Word Association Task (WAT) (Schoonen & Verhallen, 2008; see Zhang & Koda, 2017 for a review), administered in studies such as that conducted by Cremer and Schonnen (2013). This test is based on Read's (1993) format and is a forced-choice task. Ever since Read's (1993, 1998) WAT model, developed for ESL learners based on the concept of word association, various other forms of the test have been proposed based on specific design features, such as the number of choices and presentation format (e.g. Greidanus & Nienhuis, 2001; Qian & Schedl, 2004; Schmitt, Ng & Garras, 2011; Schoonen & Verhallen, 2008). Typically, in a WAT item, a target word is followed by six or eight other words, half of which are associated with the target word (i.e. associates) while the other half are not (i.e. distractors). Also, using the word associate format to investigate an L2 learner's ability to organize words in the mental lexicon and the development of different types of association knowledge has been shown to be a valid and reliable measure based on the findings of previous studies (Greidanus, Bogaards, van der Linden, Nienhuis & de Wolf 2004; Read, 1993, 1998; Schmitt, Ng & Garras, 2011; Schoonen & Verhallen, 2008).

Syntactic Processing Efficiency. In terms of linking syntactic processing to reading, effective comprehension requires a type of grammatical knowledge that can be accessed rapidly for the purpose of word-to-text integration. In other words, automatic processing and syntactic efficiency are critical for successful comprehension in reading (Zhang, 2012). In the L2 acquisition research, this has been referred to as implicit grammatical knowledge, denoting a type of knowledge that seems to require no conscious effort to access (Zhang, 2012). The results of a previous work on grammatical processing in relation to reading comprehension showed that the English-speaking fluency of 5th graders at the syntactic level correlated highly with their reading comprehension, as well as contributing uniquely to reading comprehension over and above fluency in word decoding (Klauda & Guthrie, 2008).

Very limited research has directly addressed the effect of L2 syntactic automaticity or implicit knowledge on learners' reading comprehension ability. However, the importance of efficient grammatical processing for successful reading comprehension has been widely discussed and endorsed by L2 reading researchers (Fender, 2001; Grabe, 2005, 2009; Koda, 2005; Taguchi, Gorsuch & Sasamoto, 2006; Urquhart & Weir, 1998).

Semantic Processing Efficiency. Semantic processing efficiency or the efficiency of accessing semantic network knowledge is the processing skill of rapidly activating this type of knowledge. Semantic priming can provide insights into semantic processing efficiency. This has a facilitating effect on the processing of a stimulus due to the previous processing of a semantically related stimulus (Guy & Ingram, 2009; McNamara, 2005). This facilitation can be observed experimentally in a reduction in reaction time or an increase in accuracy in an experimental task, and it is also often regarded as an online measure of the activation of semantically related words (Minzenberg, Ober & Vinogradov, 2002). It is supposed that the activation of items in the lexicon and the degree to which semantic knowledge is organized are important for reading comprehension (Ouellette, 2006; Woltz, 2003).

Only a few studies have addressed the relationship between efficiency in accessing semantic network knowledge and reading (Cremer, 2013; Nobre & Salles, 2016; Yamashita, 2013). Yamashita's (2013) study of Japanese-speaking university EFL learners found that reading comprehension was significantly predicted by learners'

efficiency of “decoding” (judgment of whether a nonsense word could be “read as an English word”) and access to lexical meaning (judgment of whether words in a pair were antonyms) measured using a paper-based, timed Yes/No decision task. Another study, undertaken with 68 participants, examined semantic processing and reading comprehension and revealed that semantic priming times correlated with the reading comprehension measure; this was found to be a predictor of reading comprehension via word reading (Nobre & Salles, 2016). Furthermore, Cremer (2013) addressed the accessibility of semantic network knowledge and found that semantic access as measured by response times in a semantic classification task could explain a small amount of variance (2%) in the reading comprehension scores of monolingual and bilingual readers, in addition to the variance already explained by vocabulary size and decoding.

2.4 Working Memory

The reading comprehension components previously discussed operate in a limited capacity system which involves memory, regardless of the model applied. Memory is divided into two main types: long-term and short-term (i.e. working memory). Both components are major resources in reading comprehension. Reading comprehension processes take place within a cognitive system that has pathways between perceptual and long-term memory systems and limited processing resources (Perfetti & Stafura, 2014). Information is held in working memory until an immediate activity ends, but some information remains stored in long-term memory (Grabe, 2009). In other words, without working memory capacity, no knowledge would be stored in the long-term memory (e.g. phonological knowledge, vocabulary knowledge, grammar knowledge) and thence rendered into a form available for interaction with other processes; therefore, comprehension cannot be achieved (Grabe, 2009). Working memory is a more important key memory concept for reading comprehension (Grabe, 2009).

The definition of working memory is far from straightforward (Alptekin & Erçetin, 2009, 2011; Jeon & Yamashita, 2014; Shin, 2020). In general, it is the capacity that applies to all cognitive processes (Jeon & Yamashita, 2014). It is also defined as a limited-capacity storage and processing system for conducting a variety of cognitive tasks that require controlled attention to allow for the active maintenance of information in the face of concurrent distraction (Alptekin & Erçetin, 2011). Working memory is responsible for the dynamic manipulation and temporary storage of information that is

necessary to manage a range of complex activities and tasks (Baddeley, 2003). It holds information that is active in processing operations and processing directions, providing the ability to simultaneously carry out multiple processes (Grabe, 2009). Thus, in performing active cognitive processes, working memory plays a fundamental role. Since comprehending a text is a cognitive activity, working memory is required for reading comprehension. It is a resource that affects an individual's ability to carry out many of the processes associated with the construction of text representation (Cain et al., 2004).

Working memory refers to the memory system used for the simultaneous storage and processing of information. It thus has both storage and processing functions (Alptekin & Erçetin, 2010, 2011; Just & Carpenter, 1992). In several previous studies of reading comprehension, working memory has been assessed in relation to both aspects or only one, but complex span tasks (i.e. the ability to store and process information) are more highly related to reading comprehension than simple span tasks (i.e. the ability simply to store information) (Daneman & Merikle, 1996).

In language comprehension research, working memory is considered a fundamental element (Alptekin & Erçetin, 2009, 2010, 2011; Cain et al., 2004; Currie & Cain, 2015; Grabe, 2009; Jeon & Yamashita, 2014). Theoretically, an increase in working memory capacity should support reading comprehension (Jones, 2018). In particular, in the Situational Model of reading, working memory is among the main elements considered to play an important role in successful reading comprehension (Kintsh, 1998). In this line, Grabe (2009) states that comprehension cannot be achieved without working memory. Working memory correlates significantly with L2 reading comprehension (Harrington & Sawyer, 1992; Leeser, 2007; Walter, 2004). In a meta-analysis that examined the overall average correlation between passage-level L2 reading comprehension and 10 key reading component variables, working memory was one of the correlates (Jeon & Yamashita, 2014). Jeon and Yamashita (2014) further argue that although working memory might not emerge as a strong correlate of L2 reading comprehension, it still one of the elements important for achieving reading comprehension. Furthermore, another recent meta-analysis of 25 primary studies by Shin, (2020) to examine the overall relationship between L2 reading comprehension and working memory measured through reading span task showed that there is a

moderate relationship between L2 reading comprehension and working memory (r = .30).

2.4.1 Working Memory and Lower-Level Processes of Reading Comprehension

The significance of working memory for reading comprehension lies in its role in various processes, particularly the lower-level processes (i.e. word recognition and word-to-text integration) (Grabe, 2009). Many reading researchers and cognitive psychologists have confirmed that each of the lower-level reading processes must compete for the limited cognitive resources available in the working memory (Crain & Shankweiler, 1990; Gibson, 1998; Just & Carpenter, 1992). This suggests the importance of including working memory in any research that aims to examine lower-level processes engaged in reading comprehension.

The relation between working memory and word recognition has been well established through its direct relation to different components of the process and its importance in holding onto relevant knowledge aspects until textual comprehension is achieved. Working memory supports word recognition through phonological, orthographic and morphological processing (Grabe, 2009). The automaticity of this processing is important because it frees space in the working memory for higher processes to be completed. For example, recent studies have reported that the capacity and efficiency of working memory could be enhanced by morphological awareness in that sensitivity to the morphological structure of words, among other functions, could “increase the size of chunks [and] decrease the number of complexity of chunks held in verbal working memory” (Zhang, Lin, Wei & Anderson, 2014, p. 14). Therefore, learners with strong morphological awareness and a more enhanced working memory would be able to free up some working memory resources to participate in the higher-level processes of text comprehension (Zhang & Ke, 2020). This could apply to all other aspects of the word recognition process.

Moreover, the word-to-text integration process also depends on working memory for completion. Working memory stores and combines words that are recognized as it carries out syntactic and semantic processing at the clause level and of the relevant information for textual comprehension (Grabe, 2009). More specifically, syntactic integration not only relies on vocabulary, but also requires working memory until

integration has taken place (Raudszus et al., 2018). Furthermore, there is evidence from the wider literature on semantic association in adults that working memory influences an individual's semantic association ability (Currie & Cain, 2015). This indicates the important role of working memory in the word-to-text integration process, whether syntactically or semantically.

The central role played by working memory in local integration processing for language comprehension is posited by the Memory, Unification and Control Framework (Hagoort, 2005, 2013). This framework emphasizes the role of control processes in guiding the unification of elements retrieved from the mental lexicon into larger units with new meaning. For example, as the reader recognizes successive words in a sentence, these words have to be held in working memory until grammatical or semantic ambiguities are resolved. In addition, the situation model of reading suggests that skilled comprehenders grasp the need to construct a coherent memory-based representation of the state of affairs described by a written text (Kintsch, 1988). More specifically, the word-to-text integration process requires working memory until integration has taken place (Raudszus et al., 2018).

2.4.2 Working Memory and Types of Reading Comprehension

Different types of reading comprehension require different amounts of working memory resources. In other words, there are substantial differences in terms of the demands placed on working memory depending on whether readers are answering literal or inferential comprehension questions. These two types of reading comprehension differ in terms of level of complexity (Sasaki, 2000), and also in the degree of activated and reconstructed schematic information stored in the long-term memory (Alptekin & Erçetin, 2011). Precisely, the more complex a task, the more it entails the contribution of knowledge based on long-term memory to working memory processing (Kintsch, Patel & Ericsson, 1999). A difficult task, for example inferential, cannot normally be tackled adequately without the efficient use of long-term memory-based knowledge structures (Calvo, 2001; Singer & Ritchot, 1996). In other words, if the reader's working memory capacity is overloaded with low-level cognitive operations, it will be unable to tackle adequately a complex process such as inferential comprehension (Alptekin & Erçetin, 2011). This means a cognitively demanding level of comprehension, such as inferential, could require not only working memory, but also long-term memory.

Alptekin and Ercetin (2009) showed that working memory capacity can be considered a predictor in L2 reading so long as the measurement makes use of composite scores that account for both storage and processing. In addition, composite scores for storage and processing correlate with inferential rather than literal understanding in L2 reading. Furthermore, based on a study conducted to investigate the relationship of both L1 and L2 reading spans with L2 reading comprehension for two reading dimensions, namely literal understanding and inferential comprehension, Alptekin and Ercetin (2010) concluded that only the reading span in L2 had a meaningful relationship with L2 inferential comprehension. Later, in another study with adult L2 learners, Alptekin and Ercetin (2011) examined the effects of working memory capacity on literal and inferential comprehension in L2 reading using reading span and assessing both storage and processing. The results revealed the independent and additive effect of working memory capacity on inferential comprehension, but no effects were observed on literal understanding. Currie and Cain (2015) conducted a study of L1 reading with children and found an association between working memory and the children's ability to generate inferences related to both local and global coherence.

Previous research has found that vocabulary mediates the relationship between memory and inference generation (Chrysochoou, Bablekou & Tsigilis, 2011). A study entering simple span and complex span as predictors in regression analysis showed that for local coherence inference, simple span and vocabulary explained 19%, and 17% variance in performance for 6-year-olds, although only vocabulary was a significant predictor when both variables were included in the model ($\beta = 0.46$**). For eight-year-olds, only vocabulary accounted for significant variance 18% in local coherence inference (Currie & Cain, 2015). More empirical studies are vital, particularly with adult learners, to support or disprove the relationship between inference, vocabulary knowledge and working memory.

2.5 Summary and Research Questions

The above theoretical and empirical discussion highlights word recognition and word-to-text integration as two important lower-level processes of reading comprehension, which operates within a limited-capacity mental system and depends on diverse types of linguistic knowledge – sub-lexical, lexical, semantic networking and syntactic – as well as the efficiency of accessing these types of knowledge. The review has also revealed several notable gaps in the literature on L2 reading comprehension.

To begin with, compared to vocabulary knowledge/size, much less is known about the role of knowledge of sub-lexical features, notably morphological knowledge; in light of the Lexical Quality Hypothesis, such knowledge should also be considered to play an important role in L2 reading comprehension. More importantly, the literature on L2 reading comprehension has paid little attention to lexical and sub-lexical processing efficiency, which theoretically should also be fundamentally important given that efficient comprehension is a goal of reading (Grabe, 2009; Koda, 2005). Furthermore, little research has aimed to test how the knowledge that underpins different word-to-text integration processes may differ in importance depending on the type of comprehension.

This thesis aims to address these gaps. To recap on the research goal, it investigates how diverse linguistic knowledge and processing skills underpin L2 reading comprehension, particularly in light of the importance of lower-level processes such as word recognition and integration. Two studies were conducted to address this goal, focusing on a group of Arabic-speaking learners of English at a university in Saudi Arabia. The two studies investigated related yet distinct issues. Whereas study 1 specifically attempted to examine how distinct lexical competences relatively and collectively predict L2 reading comprehension, study 2 attempted to assess how syntactic and semantic network knowledge might differ in predicting literal and inferential comprehension, over and beyond working memory and vocabulary knowledge/size in adult L2 readers.

The research questions for study 1 were as follows:

4. How do lexical vs. sub-lexical knowledge on the one hand, and lexical vs. sub-lexical processing efficiency on the other, relatively predict L2 reading comprehension? How do lexical-level competence (knowledge and processing efficiency) vs. sub-lexical competence (knowledge and processing efficiency) relatively predict L2 reading comprehension?

5. How do lexical knowledge vs. processing efficiency on the one hand, and sub-lexical knowledge vs. processing efficiency on the other, relatively predict L2 reading comprehension? How does knowledge (lexical and sub-lexical) vs. processing efficiency (lexical and sub-lexical) relatively predict L2 reading comprehension?

6. How do the four lexical competences – lexical and sub-lexical on the one hand and knowledge and processing efficiency on the other – collectively and relatively predict L2 reading comprehension?

The research questions for study 2 were as follows:

4. Do syntactic knowledge and semantic network knowledge, which respectively underpin the syntactic and semantic processes of word-to-text integration, uniquely predict reading comprehension in adult L2 readers of English?
5. How do syntactic knowledge and semantic network knowledge differently predict literal comprehension?
6. How do syntactic knowledge and semantic network knowledge differently predict inferential comprehension?

Chapter 3. Methodology

This chapter outlines and justifies the methodology adopted in the research considering the specific objectives of the two studies. It starts by examining the philosophical assumptions underpinning the research, i.e. the ontological and epistemological perspectives of positivism and objectivity. This is followed by a discussion of the research design, which is a non-experimental correlational design that follows a componential skills approach to the study of reading. The subsequent sections in this chapter present the participants, the sampling method, the data collection methods and procedures, the data analysis procedures and quality issues. Further details on the methods for the two studies are presented in Chapters 4 and 5. The chapter ends with a description of the ethical considerations and the procedures that were conscientiously followed in this research.

3.1 Philosophical Assumptions

The research addressed in this thesis followed a quantitative approach to test how various aspects of linguistic knowledge and processing variables contribute to EFL reading comprehension. The research methodology and methods were informed by post-positivist philosophical assumptions. Thus, the underlying ontology was post-positivist and the epistemological position maintained throughout the collection and analysis of data was one of objectivity.

The term ontology derives from Greek and refers to the study of reality, of being and the "real" nature of things (Crotty & Crotty,1998; Hammersley, 2012; Schwandt, 1997). It concerns theory about the nature of being and existence. Ontology essentially answers the question "What is reality?" (Byrne, 2016). Various ontological positions are represented in research, such as positivism, post-positivism, interpretivism and pragmatism.

The positivist ontological position holds that there is a single objective reality for any research phenomenon which is not affected by the researcher's opinion (Hudson & Ozanne, 1988). Furthermore, in positivist philosophy, the social world is external, and its properties can be measured by employing objective methods (Easterby-Smith, Thorpe & Jackson, 2012). This means that the world we are investigating has a stable and logical reality. A positivist study aims to produce objective and generalizable knowledge about social patterns to affirm the presence of universal laws in

relationships between pre-defined variables (Schrag, 1992). According to Saunders, Lewis and Thornhill (2012), the positivist view involves testing a theory and gathering facts to allow testing of hypotheses and the data obtained as part of a positivist study are generally quantitative and analysed statistically. To test a theory and to generalize the results, a large number of participants is needed to prove the relations between the variables in a study.

Prediction-based research, which characterises the present research (see 3.2 below), in its problem nature and research questions shares with positivism its basic beliefs such as collecting data from a large number of participants, using highly structured quantitative measures, and focusing on the effects of some variables while controlling those of other variables. However, in an educational context and when studying human participants, there is a difference in the degree of viewing these issues and there are a number of limitations in prediction-based research. For example, despite often controlling for many variables, prediction-based research relies on correlations and findings do not suggest any causal effect of focal or target independent variables or predictors on the dependent variable. This means that the present research fits more appropriately under the post-positivistic approach. Post-positivism is the philosophical view that argues that human knowledge cannot be proven with absolute certainty (Ruth, 2020). Investigating the interrelationships of different aspects of linguistic knowledge and processing skills with reading comprehension does not necessarily mean that these knowledge and skills cause variations in participants' reading comprehension.

Epistemology is a complex concept that is related to the nature of knowledge and knowledge generation (Guba & Lincoln, 1994; Hamlyn, 1995). Crotty and Crotty (1998) divided epistemology into three main positions: objectivism, constructivism and subjectivism. The objectivist position, which is that of the current research, entails seeking objectivity and consistency by employing rational and logical approaches to carry out the research (Carson, Gilmore, Perry & Gronhaug, 2001). Although being objective and detached throughout a study has received considerable criticism in social science research, especially in the educational field, this stance can deliver valid empirical evidence with accurate numerical data rather than offering a personal experience (Bryman, 2016). In conducting this research, the intention was to provide just such empirical evidence.

The post-positivist view is also associated with the use of quantitative methods. Quantitative research employs numerical data collection and analysis (Bryman & Bell, 2011; Greener, 2011). Furthermore, quantitative research "follows a rigid, structured and predetermined set of procedures" and "aims to quantify the extent of variation in a phenomenon" (Kumar, 2014, p. 14). It is also concerned with the common features between groups rather than individuals, identified by collecting data from large sample sizes. Although qualitative researchers have criticized quantitative research for being decontextualized and failing to get to the meanings of participants' circumstances (DonYie, 2007), it has a systematic and controlled nature, and the use of precise measurements and its capacity to generate reliable data mean that the findings can potentially be generalized to other contexts (DonYie, 2007; Saunders et al., 2012). Therefore, in this thesis, quantitative methods have been applied to fulfil the research aim of generating reliable data that can be generalized without being significantly affected by specific participants' experiences.

3.2 Research Design

The research design is the formal plan for the procedures employed to collect, analyse, interpret and report the data (Creswell, Klassen, Plano Clark & Smith, 2011). In other words, the research design is a road map that a researcher follows to find answers to research questions as accurately as possible (Kumar, 2014). In line with the positivist perspective, this research adopted a non-experimental quantitative correlation-based design in the two studies, or more precisely a prediction design, to investigate how various linguistic knowledge and processing skills underlying lower-level processes predict EFL reading comprehension based on correlational associations. Although the two studies were distinct in focus, they both adopted this specific design towards achieving a common goal of understanding lower-level processes in L2 reading comprehension.

The correlational design aims to discover the relationships between variables through the use of correlational statistics, namely the correlation coefficient (r) (Gavin, 2008). The square of the correlation coefficient yields the explained variance (r^2), in other words, how much variability in the dependent variable could be attributed to its relationship with an independent variable (Gavin, 2008). In both studies, the application of the correlational design helped undertake various procedures regarding data collection, analysis and reporting of results that were suitable in terms of

generating valid and reliable answers to the research questions. It also made it possible to examine the complex interrelationships between variables systematically and objectively based on theoretically informed statistical models using quantitative methods.

Aligning with the prediction-based design, the research more specifically adopted the componential or component skills approach in examining reading comprehension. The componential approach, as mentioned in Chapter 2, is one that is adopted in reading research because it decomposes reading skills into various components and uses correlational associations to model their complex interplay in accounting for individual differences in reading outcomes. Following this approach involves collecting and analysing large, multi-measure databases; the measures that are chosen in such research aim to tap a wide range of reading-related processes and all of the measures are administered to each of the subjects in a sample representing a population whose reading ability one wishes to characterize (Carr et al., 1990). It is believed that the results of component skills analysis are the only way of obtaining an accurate picture of reading ability (Carr et al., 1990).

3.3 Participants

The population of the research comprised adult EFL Arabic-speaking university students in Saudi Arabia. The decision to focus on this population was based on the limited attention paid to them in the L2 reading literature, as well as issues of accessibility, based on a shared linguistic and cultural background, namely that I as the researcher am also an Arabic speaker and learned EFL as a university student in the same context. It was clearly not possible to include all adult EFL Arabic-speaking university students in Saudi universities. This resulted in selecting a sample to represent the common characteristics of the larger population.

The sample of this study was chosen from one of the Saudi universities, Taif University (see Section 1.5). Taif University was chosen as the site for the study because Taif is the city where I had lived, and I had worked at the university. I had connections with English language teachers at the university and am familiar with English language teaching there, which was considered to facilitate data collection for this research. Nevertheless, my acquaintance with participants' teachers could raise concerns about potential bias during the data collection process (see 3.4 below). To avoid any bias,

some careful considerations were taken. For example, I randomly selected a class(es) taught by a particular teacher rather than let the teacher decide which class I should visit for data collection. In the information sheet, and when I verbally introduced the project to participating classes, I made it clear to students that their responses to the tests had nothing to do with the English course, and their responses or performance on the tests would not be shared with their teachers. Students were also informed that their academic standing in the English course would not be affected by their choice to participate or not to participate or withdraw from the study.

Although the target population for the project was university students, both male and female, data were collected only from female students. Females are separated from males in most Saudi universities due to the conservative cultural tradition. The choice of a female campus over a male one was that it was the only option accessible to me, as a female researcher, to collect data from individuals and using face-to-face testing.

There are various sampling methods, either probability or non-probability. Probability sampling is the most applicable and widely employed sampling strategy in quantitative research (Curtis, Murphy & Shields, 2013). Probability sampling reflects the philosophical assumptions of positivist researchers, including equality and objectivity regarding participants' selection to be part of the study and generalizability of the findings (Greener, 2011). However, this research employed non-probability convenience sampling, a method that does not allow an equal chance for all members of the population to take part (Ary, Jacobs, Razavieh & Sorensen, 2009; Bryman, 2016; DonYie, 2007). This was more feasible than probability sampling in terms of enrolling subjects according to availability and accessibility. Non-probability convenience sampling is allowed and actually common in quantitative research as long as the researcher can ensure the sample reflects the study population relatively well to ensure the results can be generalized with confidence.

Data for the two studies were collected from the same group of 268 EFL university students. Not all students completed all the tasks for each study. In each study, some participants were excluded due to missing some of the measures for various reasons, such as absence from class or scheduling conflicts. In other words, a few cases, then omitted from the analysis, missed one or more of the group- or individual-based testing sessions. Eventually, 48 students with missing data were excluded from the analysis

in study 1 and 39 from the analysis in study 2. All the analyses reported in the results sections for each study were based on cases with full data (see Chapters 4 and 5 for more details).

To recruit the participants, a set of procedures was followed. After attaining ethical approval and permission to collect data from the University of Exeter (for more detail, see 3.9 Research Ethics), the documents were provided to the research office administrator at Taif University, who granted permission to contact administrators or coordinators in different departments to access their English language teachers. I then liaised with those language teachers to recruit participants from among their students. Specifically, I was assigned to meet some language teachers and lecturers and explain to them their roles and the time needed to complete the data collection, as well as addressing any arrangements that had to be made. Those willing to allow access to their classes announced and explained to their EFL students the details of the research to encourage them to participate. Then, I visited the classes to explain the research and its risks or benefits to prospective participants. Informed consent was obtained from all participants willing to be part of the project before the tasks described below were administered (see 3.9 Research Ethics).

A short English language learning background questionnaire was first administered to the participants in advance of any other instruments to obtain information about the participants. The questionnaire asked their age, major, English language learning background and other information related to their reading skills in English. This questionnaire was administrated in Arabic, i.e. the native language of the participants, to ensure their full understanding of the items and to enable them to provide accurate responses (see Appendix 5 for the English language version of the questionnaire). The questionnaire was initially constructed in English and then translated by me, as a native speaker of Arabic and a fluent speaker of English, and the translated version was reviewed by an expert in translating documents from English to Arabic. The questionnaire contained 10 items.

The results showed that the participants' ages ranged between 17 and 22 years old and the mean age of the participants was 20 years, with only three cases older than 22 years. They were all female students representing a range of undergraduate majors offered by one of the Saudi universities. Specifically, they were from different majors

in two colleges: Science (Chemistry, Nutrition and Computer Science majors) and Humanities (Media and English Language majors).

The participants' responses showed that most of them had started learning English when they were about 12 years old. At this age, most Saudi public schools offer English as a compulsory subject. In other words, most of the participants had learned English for at least six years before they commenced their undergraduate studies at the university. A minority of the participants had started learning English in pre-primary education or at different grades of primary education, for example aged 7 or 9 (for more details about the context, see 1.5 Context of Research).

Further information was obtained about their English language learning. Learning English at school was the main – indeed only – driver of the participants' interest in learning the language. Most participants spent less than 6 hours per week learning or reading in English, which could indicate intermediate language proficiency. Some self-assessment questions revealed that most of the participants assessed their English language performance in reading comprehension as moderate. Approximately half of the participants (41.5%) evaluated their motivation to read in English as high. However, around 53% of the participants stated that the main source of reading texts in English was schoolbooks, suggesting perhaps limited availability of reading sources in English, a lack of interest in different reading sources, and potentially a lack of extensive reading skills practice.

3.4 Data Collection Instruments and Procedures

The English language learning background questionnaire was followed by administering a battery of paper-based and computer-based tests (see Figure 3.1), which are outlined below. Details of each task are presented in the methods section of Chapters 4 and 5. Data collection was completed over about eight weeks. It was mainly divided into two phases: the paper-based testing phase and the computer-based testing phase. The former was usually carried out first with most participants. The procedures for the paper-based measures and computer-based measures differed.

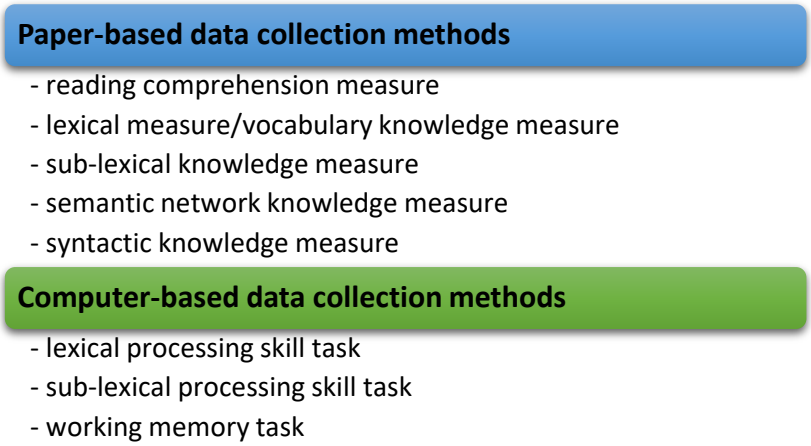

Figure 3.1. Data collection methods.

3.4.1 Paper-Based Measures

As shown in Figure 3.1, the paper-based measures assessed reading comprehension, lexical knowledge/vocabulary size knowledge, sub-lexical/morphological knowledge, semantic network knowledge and syntactic knowledge. These were administered to students in six short sessions in their regular English classes. Specifically, the three tasks of the sub-lexical/morphological knowledge measure were administered in one session; the lexical knowledge/vocabulary size measure, semantic network knowledge and the syntactic knowledge measure were administered in three separate sessions. The reading comprehension test was administered in two class sessions, two passages in each session, and each session lasted about 25 minutes.

The participants were primarily asked to match items or to choose the correct answer. Some of the tasks also provided an example with a sample answer and an explanation for the answer to avoid any misunderstanding and demonstrate the correct way to answer. In addition, Arabic translations of some of the English language items and choices were provided. Further details of the core paper-based methods that were sources of data for both studies are provided below; some were only data sources for one study, presented in Chapters 4 or 5.

First, for the paper-based measures, I negotiated possible ways of administering the tests with the teachers and we decided on doing so on a group basis in six class sessions. A total of two hours to complete the paper-based testing was divided into different sessions, each session lasting for about 20–25 minutes based on the

participants' convenience. The sessions were conducted at the end or at the beginning of their English language classes. Participants were provided with the paper version of each task and were asked to record their responses without discussing them with other classmates and without help from their classmates or the teacher. They were also asked to write their university number on the top of each measure. They had to finish each task within the time assigned for that task. I monitored them and offered verbal explanations when needed. Instructions were given in Arabic, the participants' native language, or Arabic and English to ensure participants' full understanding of the questions.

3.4.2 Computer-Based Measures

Processing skills in terms of efficiency or fluency have not been included to any great extent when studying individual differences in L2 reading comprehension. Essentially, in L2 research, there has been a strong focus on linguistic processing at various levels; however, in reading comprehension studies following a componential approach, there has been a heavy reliance on paper-based knowledge measures, but a lack of latency-based efficiency measures as noted in Chapter 2 (Harrington, 2018). Processing skills were assessed in this study using computer-based methods.

The computer-based measures were administered individually to participants on a laptop computer and run on PsychoPy Version 3.0 (Peirce et al., 2019). The computer-based testing was conducted in a quiet space on the university campus in one session, which lasted about 15 minutes. Regarding the individual computer-based testing session, the teachers' help was needed with the signup process using the university website. A daily schedule for meeting with the students was published on the course site, which is part of the university website, to which all the students had easy access and could choose a suitable date and time to take part in the session. Although help from the English language teachers was needed to meet the participants in class time, it was explicitly explained to participants that their performance on the tests would have no bearing on their academic standing in the English courses they were taking.

The computer-based testing session involved a lexical processing task (i.e. lexical decision task), sub-lexical processing tasks (i.e. morphological segmentation and combination) and a working memory task (i.e. digit forward and backward span task), as described in Figure 3.1. Some considerations have been taken regarding the

procedures of assessing lexical and sub-lexical processing efficiency and working memory capacity, such as deciding on the needed time from participants to read and respond. Zhang and Lu (2014) argue that the time that is given to the participants to read the choices and decide the correct answer could have contributed to the participants' response times. Further considerations were taken regarding the time between each item (i.e., elapse time), and the usage of milliseconds in reporting the reaction time.

The working memory task was administered first, followed by other processing efficiency measures. For all the measures, testing began with on-screen instruction and some practice items for each task that were not then included in the analysis to assure understanding before the start of actual testing. Participants were asked to give a response or make a decision for an item presented in the center of the computer screen by pressing as quickly and accurately as possible “Yes” (the left arrow key) or “No” (the right arrow key) marked with stickers on the keyboard.

The reaction times (RTs) for answering each item, giving Yes/No responses, were recorded. The RT was calculated as the interval between the onset of an item appearing on the computer screen and the time of Yes/No being pressed. Participants began the test by seeing an item appear in the centre of the computer screen for a certain time. The time that elapsed (the time assigned for an item to be answered) before disappearing was tailored to each task based on the pilot study (see section 3.5.3), but generally ranged from 1000 ms to 2000 ms. Pressing the Yes/No key would automatically activate the next item. If the “No” key was pressed for an item or no response was detected after the fixed rate of time, the item would automatically disappear and the next item would appear.

3.5 Data Quality

The quality of the findings of a study and the possibility of generalizing results depend on the quality of the data. In this research, to ensure data quality, a number of validity and reliability aspects were considered. For example, the clarity of instructions is fundamental for data quality and the validity of the research findings. To ensure the clarity of instructions, various procedures were followed, such as providing verbal explanations of the tasks. In addition, the instructions were given in both English and Arabic (the participants’ native language) to ensure full understanding of the questions.

Furthermore, a pilot study was conducted to refine some tasks before they were administered to the participants, i.e. before the actual data collection.

3.5.1 Validity

Validity is the extent to which a data collection method accurately measures what it was intended to measure (Saunders & Lewis, 2012). To fulfil this criterion, the internal content validity of each method was evaluated to ensure that it adequately covered the intended domain. The research adopted well-known instruments that are firmly established and widely used in the literature, making some adjustments to ensure they were suitable for the study participants. Furthermore, the completed versions of the data collection instruments were reviewed by five native speakers of English and English instructors to check the clarity of items. They were also reviewed by the research supervisor, who is a professor in the field of language learning, to check whether the measures adequately covered the areas to be investigated with careful consideration of each item in the measures. Subsequently, several suggested amendments were made to different versions of each instrument.

3.5.2 Reliability

The reliability of an instrument is "how free it is from random error" (Pallant, 2016, p. 6). The reliability of the research methods was assessed by measuring the internal consistency of each scale item, namely the extent to which the item measured the same attribute (Pallant, 2016). In other words, reliability informs the researcher how consistently a method will measure something when the same method is applied with the same sample under the same conditions, such that the same results should be attained. This was accomplished by estimating the Cronbach's alpha coefficient for each instrument, with the acceptable value being no less than 0.6. Estimating the Cronbach's alpha coefficient values of each instrument in the pilot study made it possible to ensure that the final versions of the data collection instruments achieved reliability. The precise Cronbach's alpha values for each instrument are provided in Chapters 4 and 5.

3.5.3 Piloting

To ensure the professional appearance of the tests and the clarity and suitability of the items for the purpose for which they were developed, as well as the smoothness of the procedures, it was essential to pilot the data collection methods and procedures

before starting actual data collection. In other words, piloting would assure the validity, reliability and feasibility of the data collection methods and procedures. Moreover, piloting the methods made it possible to estimate the average time needed to complete each test. Therefore, a pilot study was conducted with 30 participants from the same target population but who did not participate later in the main study.

This phase was completed over four weeks for all instruments. Following completion of data collection in the pilot study, I had a quick informal chat with some of the participants, enquiring about the clarity of the methods and any related issues. In response to the participants' suggestions and answers, modifications were subsequently made to the wording of some questions to improve their clarity, and some items were added or deleted.

3.6 Data Management, Coding and Scoring

The collected data were carefully managed by following several procedures to handle the data and to code the responses. Before main analyses were conducted, the data set was examined for missing data, outliers, skewness and kurtosis, and basic assumptions for analysis within the general linear model framework. These procedures differed for the paper-based and computer-based tests. Additional specific procedures were adopted for some measures, detailed in the methods sections in Chapter 4, section 4.3.2, and Chapter 5, section 5.3.2.

3.6.1 Paper-Based Tests

For the paper-based tests, the test papers were carefully matched for each participant using their university ID number, which was recorded on each paper. A paper without an ID number was excluded. The next step was to record the participants' responses digitally, entering them into an Excel sheet as a raw data file considering all the responses received as they were. A missing response was coded as missing (i.e. a blank in the Excel file with no digit). This was followed by a process of coding or scoring the responses. In the coding process, correct answers were computed as 1 (in other words, one point was awarded) and wrong answers as zero. Items with two choices selected were recorded as zero and missing data were also recorded as zero for all knowledge measures. The participants' scored answers were transferred to an SPSS file for each task and the total score was computed by adding up the scores across all items for the task.

For the reading comprehension test, a special procedure was adopted to calculate the total score. The four passages were administered in two separate sessions (see the methods section 4.3.2 in Chapter 4 for further information). Some participants attended only one session of the two and thus were excluded from the data analysis. Only participants who attended both sessions were included.

Moreover, slightly different procedures were adopted for scoring the syntactic knowledge measure and the error identification and correction task. One point was rewarded for correctly identifying the grammatical error in a sentence. Another point was rewarded when the participant correctly amended the grammatical error identified (see the methods section in Chapter 5 for further information).

3.6.2 Computer-Based Tests

To manage and code the data obtained from the computer-based tasks, the software program PsychoPy generated a separate Excel file for each participant with a ready coding of the correct answers as 1 and incorrect answers and missing data as zero. It also provided an accurate calculation of the participants' RTs for each item, whether the response was correct or not. The RTs of missing decisions were coded as missing.

The scoring and handling of the missing data for the computer-based tasks was less straightforward than for the paper-based tasks because there are no consistent methods for handling such data in decision tasks like those used in this research (Jiang, 2012). In the literature on L2 reading comprehension, while some studies consider both accuracy and RTs (e.g. Cremer & Schoonen, 2013), others incorporate only RTs in their analysis (e.g. Van Gelderen et al., 2004). In this research, both accuracy and RTs were considered for analysis of all computerized measures. This was also in line with the purpose of the research, namely to compare different aspects of knowledge against processing skills, and thus it was of greater interest to examine participants' decision latency.

In calculating the correct RTs for analysis, there were several stages. First, the RTs of missed or incorrect decisions were recoded as missing. Only the RTs of correctly answered items were included in calculating the mean (i.e. the average) of the RTs for each item. An RT that was above or below the item mean by two or more standard deviations was considered to be an outlier and further recoded as missing in accordance with a criterion used in several papers (Holderbaum & Salles, 2011).

Then, the mean RT for each participant was calculated based on only the RTs of correct items and after excluding the outliers, identified as the raw RTs. In addition, the accuracy of the responses was calculated. Finally, to accommodate the rate of correct responses and their RTs, the raw RTs were replaced by an inverse efficiency score (IES), which was calculated for each participant by dividing the raw mean RT by the percentage of correct responses (Ratcliff, 1993; Townsend & Ashby, 1983). In other words, participants with a low RT but also a low accuracy rate were penalized for the low accuracy.

3.7 Data Analysis Methods and Procedures

The data were analysed primarily through bivariate correlation hierarchical regression for both studies. Correlational analysis is a statistical technique that makes it possible to analyse whether, and how strongly, sets of variables are related (Gavin, 2008). Covariance analysis was also undertaken, combining regression analysis with analysis of variance by measuring one or more variables in addition to the dependent variable (Kirk, 2009). Through the analysis of covariance, the dependent variable is statistically adjusted to remove the effects of an uncontrolled source of variation (Kirk, 2009). The analysis was completed using the IBM SPSS Statistics 26 program.

For each study, a separate SPSS data file was created that included all the focal variables of the study. For study 1, the focal variables were reading comprehension, lexical knowledge, sub-lexical/morphological knowledge, lexical processing efficiency, sub-lexical/morphological processing efficiency and working memory. For study 2, the focal variables were reading comprehension, with separate columns for the totals of literal and inferential reading comprehension, lexical knowledge, semantic network knowledge, syntactic knowledge and working memory. In each data file, cases with missing values were excluded from the analysis. In other words, only cases which had a score for all focal variables were retained in the dataset for analysis.

For each study, some descriptive analysis, including the estimate of means, standard deviations, skewness and kurtosis, was conducted. Then, the bivariate correlations were calculated, followed by a set of hierarchical regression analyses. In both studies and in all regression analyses, working memory was entered first into the regression equation as a covariate because this was one of the core aspects in data collection employed in both studies. This was followed by the predictors in different orders. To

explore the unique effects of the predictors, the orders of the linguistic processing predictors were adjusted in each study (see results sections in Chapters 4 and 5).

3.8 Research Ethics

Research ethics is generally associated with the appropriateness of the researcher's procedures and behaviours regarding the rights of participants, particularly the procedures of obtaining access, collecting, analysing and storing data, as well as moral and proper procedures for presenting the findings (Saunders et al., 2009). Researchers must consider research ethics to avoid any potential psychological, social, or physical risks that could arise for the researcher or the people involved (Cohen, Manion & Morrison, 2018). In this research, the ethical guidelines of the British Educational Research Association (BERA, 2018) were adhered to, ensuring that any actions were ultimately seen to be ethical, justifiable and sound. These ethical guidelines were followed with care throughout the research stages, starting from obtaining formal permission from the educational institutions and regarding any decision related to accessing the participants and the responsibilities towards them, such as gaining informed consent, and ensuring anonymity and confidentiality.

Careful consideration of the ethical issues and the impact of the research on all those involved is a critical issue in educational research. Educational institutes, such as the University of Exeter and Taif University (i.e. the educational institutions related to this research), understand this major concern and usually require researchers to go through an ethical approval process in which the project and methods are reviewed carefully before giving permission for the study to be conducted (see Appendices 1, 2 and 3). These approvals were initiated before any contact with the potential participants and before collecting any data and they identified some responsibilities towards the participants. These responsibilities included obtaining voluntary informed consent, stating the right to withdraw, ensuring anonymity and confidentiality, committing to openness and providing full disclosure.

Being ethically committed to the participants, I conscientiously shared as much information about the research as possible, bearing in mind any negative implications of doing so for the data produced. This was facilitated by distributing paper copies of the information sheet (see Appendix 4). The information sheet was given to the potential participants in their classes, along with a verbal explanation of each section

in the information sheet. The information sheet contained the research title, an invitation to participate, including the research information, the participant's rights, the participant's role, arrangements for handling the data collected and study results, and contact details. The participants were also informed of any potential benefits and risks arising from their participation in the research. They were asked to read the whole information sheet and to consider it carefully before deciding to participate and signing the consent form, and they were given the chance to have any questions clarified before they signed consent.

Consent form was obtained individually from each participant. The form covered the following issues: confidentiality, anonymity, information about the project, and the right to withdraw at any time without disadvantage to the participant and without needing to explain. At the end of the consent form, the prospective participant was asked to write her name and sign two copies, one for the participant and the other for the researcher. Both the information sheet and the consent form were provided in their native language (Arabic) to assure full understanding of the content of the information sheet and the consent form.

Confidential and anonymous treatment of participants' data is of great importance. In this study, the participants were asked to use their university ID numbers, not their names, in all the tests so that they would not be traceable or recognizable in any way to protect their privacy. Furthermore, data analysis was conducted at the group level and this resulted in reporting the results of the participants as a whole group rather than referring to any individual students.

There was no potential for psychological, legal, political, financial, or physical harm either to the participants or to myself as the researcher. More precisely, there was no possible harm to me, as I am a Saudi citizen and have worked in the university where I collected the data. I received help from colleagues in the data collection stage. In addition, the study was conducted on Taif University's female campus, which was a convenient and safe place to meet, both for the participants and for me. Concerning the participants, given the time needed for each participant to answer the test questions, data collection was divided into different sessions based on the participants' convenience and that of their classes. The total time for both paper-based testing and computer-based testing was less than three hours. The paper-based testing in a

whole-class format took a total of two hours, divided into six sessions of 20–25 minutes each over eight weeks in class time, by arrangement with their teachers. About 15 minutes was needed to complete the computer-based, individual testing session, which was divided into several sub-sessions, with short breaks between tasks.

The data for this research were held in accordance with the Data Protection Act and adhered to the procedures for data protection stipulated by both the University of Exeter and BERA (2018). To protect the data, ensuring that they were held securely, in confidence and used only for the purposes of the research, with no access permitted to third parties, several measures were taken. The consent forms with the participants' signatures were scanned to digital copies, stored on my account on the University of Exeter's secure OneDrive, then shredded and safely disposed of in Saudi Arabia before I returned to the UK. Similarly, the participants' responses to the questionnaire and test papers were digitized and uploaded to OneDrive. Students' responses to the computer-based tests were also uploaded to OneDrive and then deleted from my personal computer. In addition, the participants were informed that the results of the research would be published in this PhD thesis and other publications (i.e. journal articles), as well as being presented at academic conferences, seminars and symposiums.

Chapter 4. The Lexical Basis of L2 Reading Comprehension: From (Sub-) Lexical Knowledge to Processing Efficiency[1]

This chapter presents study 1, which explored the lexical basis of L2 reading comprehension with a focus on lexical and sub-lexical competences, including knowledge as well as processing skills. It begins with a review of relevant literature of this study's variables. This is followed by a description of the methods, including details of the tasks which were employed to collect this study's data. Key findings and a critical discussion of these findings are then presented. Finally, this chapter ends with some conclusions and limitations, which could be directions for future research.

4.1 Literature Review

Theoretically, reading comprehension necessitates various lower-level processes, including notably word recognition, which depends on different lexical and sub-lexical competences. The Construction-Integration Model (Kintsch, 1988) contends that the process of text comprehension starts with the reader accessing and integrating word meanings for establishing a text model, and then the reader building a situation model through activation of background knowledge and various inferencing processes. Thus, to comprehend a text, readers need to recognize the individual words that make up the text and access their meanings. This importance of efficient word recognition was underscored in the Verbal Efficiency Theory (Perfetti, 1985) and later in the Lexical Quality Hypothesis (Perfetti, 2007). The Lexical Quality Hypothesis (Perfetti, 2007) places lexical representations and processes at the center of a Reading Systems Framework (Perfetti & Stafura, 2014). It contends that high-quality lexical and sub-lexical representations are fundamental for efficient word recognition (and word-to-text integration, which is the focus of the next chapter) and consequently, text comprehension (see Chapter 2, section 2.3.1). These representations involve the features of four constituents of word identity: orthography, phonology, semantics, and morphosyntax (Perfetti, 2007). Together, the quality of these four features and the coherence among them facilitate the rapid, low-resource retrieval of lexical word identities and their integration into a mental model of the text (Perfetti, 2007; Perfetti & Stafura, 2014).

[1] A version of this chapter was submitted to *Language Learning* for consideration of publication. At the time of preparing this thesis for submission, the paper is under review with the journal.

An efficient word recognition process for text comprehension necessitates not only rich knowledge of word meanings but also an ability to process printed words and access their meanings rapidly, that is, lexical processing or word recognition efficiency. There is extant literature on (sub-)lexical competences associated with word decoding/recognition and textual comprehension in monolingual reading. In contrast, much less is known about how these competences underlying word recognition may impact L2 reading comprehension, particularly that in adults EFL learners. In addition, studies that explored lexical underpinnings of L2 reading comprehension tended to focus primarily on lexical/vocabulary knowledge, particularly vocabulary size. There is little attention to how (sub-)lexical processing efficiency may play a unique role, over and above *knowledge*, in L2 reading comprehension. The present study aimed to address these gaps. [2]

4.1.1 Lexical Knowledge and Reading Comprehension

Lexical knowledge was narrowly defined in this study as learners' knowledge of the meanings of individual words, that is, vocabulary size or breadth, as generally understood in the literature. The importance of lexical knowledge in text comprehension can be well understood from a strand of L2 research that focuses on lexical coverage and adequate comprehension of texts (e.g., Hu & Nation, 2000; Laufer, 1992; Laufer & Ravenhorst-Kalovski, 2010; Schmitt, et al., 2011). Hu and Nation (2000), in their well-cited study, for example, concluded that learners need to know as much as 98% of the words in a text to achieve adequate comprehension of that text. This study further found that for learners to achieve reasonable, unassisted comprehension of a text, it is necessary to have a vocabulary of around 5000 words.

[2] Depending on their context of use in the literature, "word knowledge," "vocabulary knowledge," and "lexical knowledge" may have distinct meanings. In this research, and specifically in this study, while the concepts of vocabulary size and vocabulary depth when reviewing some L2 literature were referred to, it was preferred to use "word-level/lexical" and "sub-word level/ sub-lexical" knowledge and processing in light of the Lexical Quality Hypothesis. This is also because vocabulary depth seems to be an obscure construct in that diverse types of knowledge other than vocabulary size are often lumped together to define it (Li & Kirby, 2014; Schmitt, 2014; Zhang & Koda, 2017). Sometimes, lexical processing or fluency is even conceptualized as a component of vocabulary depth knowledge. To study complex lexical processes in reading comprehension, it is unhelpful to adopt the simple distinction between vocabulary size and depth without clearly distinguishing the specific types of knowledge in question, on the one hand, and the distinction between knowledge and processing efficiency, on the other. To this end, "lexical competence(s)" was used in this study as the umbrella term for knowledge as well as processing efficiency at both word/lexical and sub-lexical/morphological levels.

They concluded that knowledge of the vocabulary in a text is one of the key factors that affect the ability to understand a text while reading.

The number of words whose meanings are known to a reader should positively strongly correlate with their reading comprehension ability. Grabe (2009) highlighted that the correlation between vocabulry knowledge and reading comprehension should be as high as over .90. Many studies on L2 readers of English, including studies on Arabic-speaking readers, have revealed strong positive correlations between the number of words whose meanings are known and reading comprehension ability (e.g., Farran, Bingham & Matthews, 2012; Qian, 1999; Zhang, 2012; Zhang & Koda, 2013).

Qian (1999), for example, explored the relationships between breadth of vocabulary knowledge and reading comprehension in a group of young adult learners of English as a second language (ESL). The results showed that vocabulary size and reading comprehension are highly, and positively, correlated. Moreover, scores in vocabulary size made a unique contribution to the prediction of reading comprehension levels. Later, Farran, et al. (2012) examined the relationship among multiple components of language, namely, phonology, morphology, and vocabulary and reading outcome in 83 bilingual English-Arabic children. They found that in both Arabic and English languages, children's vocabulary knowledge predicted their reading comprehension. This finding is consistent with the tenets of the extended version of the Triangle Model of reading (Seidenberg, 2005), which underscores the importance of multiple language components in predicting reading outcomes.

Focused on advanced, adult Chinese-speaking EFL readers, Zhang (2012) found that vocabulary size was significantly correlated with reading comprehension subskills: textual inference, gist, and co-reference (r = .316, .343, .278, p < .001, respectively). Vocabulary size was assessed using the Vocabulary Levels Test (VLT), which focused on form-meaning connections. Zhang and Koda's (2013) study with 245 sixth graders of a public elementary school in China, who started learning English from Grade 3 onward, also identified a positive correlation between vocabulary knowledge and reading comprehension (r = .431, p < .001).

The centrality of knowledge of word meanings in L2 reading comprehension is also evident in a few research syntheses (Choi & Zhang, 2018; Jeon & Yamashita, 2014; Melby-Lervåg & Lervåg, 2014). Jeon and Yamashita's (2014) meta-analysis, for example, showed that vocabulary knowledge is one of the strongest correlates of L2 reading comprehension (only next to grammatical knowledge) (on average r = .79). The meta-analysis included 29 studies and 4,923 participants ranged from kindergarten children to postgraduate level students. Those studies involved a number of L2 languages such as English, Spanish, German, Arabic, and Japanese; and study participants' L1 was also diverse, including Spanish, Chinese, English, Japanese, Korean, Arabic, Farsi, Hebrew, and Dutch.

Melby-Lervåg and Lervåg (2014) conducted a systematic meta-analytic review of 82 studies comparing reading comprehension and its underlying components that is language comprehension, decoding, and phonological awareness in first- and second-language learners. Language comprehension is the ability to understand the meaning of words and sentences in a language which are crucial antecedents for reading comprehension. Comparing the first-language learners to second-language learners, a large deficit in language comprehension was displayed, but only small differences in phonological awareness and decoding.

Add to that a recent research synthesis by Choi and Zhang (2020) synthesized the findings in the literature on the relative contribution of two types of linguistic knowledge that is vocabulary and grammatical knowledge to L2 reading comprehension. This systematic review included 19 studies with different age levels of participants starting from elementary level to university level, language context (i.e., second versus foreign language), and method of analysis (e. g., basic correlations, multiple regression, or structural equation modeling (SEM)). Overall, they all agreed that vocabulary is an important factor underpinning L2 reading comprehension.

This all confirmed the importance of lexical-level knowledge which stands for vocabulary size/breadth in the word recognition process for reading comprehension on diverse groups of second language readers. This leads to examing the role of the second level of lexical knowledge underpinning the word recognition process which

is the sub-lexical level that was investigated in the current study. Specifically, only morphological knowledge aspect of sub-lexical level knowledge aspects was included.

4.1.2 Sub-lexical/Morphological Knowledge and Reading Comprehension

Compared to the wide recognition of and strong empirical evidence on the importance of lexical level knowledge, that is the knowledge of the word meanings in the context of this study in L2 reading comprehension, the attention is limited in the literature to the important role of knowledge of sub-lexical level features encapsulated in the Lexical Quality Hypothesis (Perfetti, 2007). Additionally, the binding of constituent features (i.e., constituent binding) also plays an essential role. Accordingly, "sub-lexical level of lexical knowledge" refers to knowledge of sub-lexical features, notably morphological knowledge, which is sometimes considered to be a type of vocabulary depth knowledge (Nation, 2001; Qian, 1999).

Morphology, in particular, has been underscored as an important constituent binding mechanism; and morphological representations have a strong implication for reading acquisition (Bowers, et al., 2010; Kirby & Bowers, 2017). For example, English derivation, in addition to modifying the part of speech and meaning of the base word to which a suffix is added, is often characterized by phonological and/or orthographic change to the base word as well (e.g., *apply* → *applicable*). Theoretically, morphological knowledge (and processing, which is discussed in the next section) should also play an important role in the comprehension of English texts, where multimorphemic words are prevalent (Nagy & Anderson, 1984).

In fact, Jeon and Yamashita's (2014) meta-analysis revealed that on average (k = 6, which was notably smaller than vocabulary knowledge, for which k = 31), morphological knowledge had a correlation of .61 with L2 reading comprehension. Thus, even though morphological knowledge, like orthographic knowledge (r = .51) and phonological awareness (r = .48), was categorized in the meta-analysis as a low-evidence predictor of reading comprehension because of the small number of correlations retrieved from the literature, the moderate average correlation does seem to lend clear empirical support to the importance of morphology in L2 reading comprehension. The issues that wait to be further explored in the L2 literature,

however, are often *how* morphological knowledge is important for reading comprehension and whether it predicts L2 reading comprehension over and beyond lexical knowledge.

Theoretically, morphological knowledge, such as knowledge of roots and affixes, can contribute to text comprehension, independent of lexical knowledge, through at least two major mechanisms. On the one hand, the reader can apply morphological knowledge for more accurate and rapid recognition of morphologically complex words in a text by, for example, dividing those words into their morphemic constituents; on the other hand, morphological knowledge serves as a reliable strategy for the reader to unlock meanings of unknown words in textual reading, that is, instantaneous resolution of vocabulary gaps during reading or "on the spot vocabulary learning" (Nagy, 2007, p. 64).

The empirical literature, however, has produced inconsistent findings. Some previous studies showed that morphological knowledge contributed to text comprehension, independent of lexical knowledge (Kieffer & Lesaux, 2008; Zhang, & Koda, 2013; Zhang, 2017). Zhang and Koda (2013), for example, found young Chinese-speaking EFL learners' English morphological awareness, which covered both derivation and compounding, predicted their reading comprehension, over and above vocabulary knowledge (or lexical level knowledge as defined for the purpose of the present study). They differentiated between basic and refined faces of inflectional, derivational, and compound awareness of the participants by considering basic facet as learners' sensitivity to the structure of multimorphemic words, such as the ability to segment words into constituent morphemes and to identify the affix (for affixed words) and the structural relations between constituent morphemes (for compound words), and refined facet as the knowledge of the function of affixes (for affixed words) and the competence to discriminate meanings of roots (for compound words). They found that learners' basic facet of inflectional awareness was better than that of derivational awareness; their compound awareness was better than derivational awareness, for both basic and refined facets. Additionally, the advantage of compound awareness over derivational awareness was smaller for the basic facet than for the refined facet.

Similar findings were also reported in some studies on young bilingual readers (e.g., Kieffer & Lesaux, 2008; Zhang, 2017). Kieffer and Lesaux (2008) examined the relationship between morphological awareness and reading comprehension in English among Spanish-speaking English language learners (ELLs) followed from fourth through fifth grade. This study found a relationship between morphological awareness and reading comprehension, and it strengthened between fourth and fifth grade, and in fifth grade, morphological awareness was found to be a significant predictor of reading comprehension. They concluded that derivational morphology awareness plays a role in the reading comprehension of Spanish-speaking ELLs in the upper elementary school years when controlling for the influence of some elements including vocabulary breadth.

Later, Zhang, (2017) examined the contribution of morphological awareness to English as a Second Language reading comprehension in a longitudinal study. Similarly, it revealed that morphological awareness had a significant direct effect on reading comprehension over and above vocabulary knowledge, and such an effect became stronger over time. This study found that derivational awareness directly and significantly predicted ESL reading comprehension over and above the influence of learners' lexical skills. It also indirectly contributed to ESL reading comprehension primarily via learners' vocabulary knowledge; the contribution also became strengthened over time.

On the other hand, a significant, unique effect of morphological awareness in English reading comprehension did not surface in some studies after controlling for the effect of vocabulary knowledge (Farran et al., 2012; Qian, 1999; Zhang & Koda, 2012). In the study of Farran et al. (2012) on grades 3 and 5 Arabic-speaking bilingual readers of English in Canada, English morphological awareness barely explained any additional amount of variance in English reading comprehension after vocabulary knowledge was also in the regression model (vocabulary knowledge was actually the strongest predictor of reading comprehension; see Table 7, p. 2175).

Likewise, Qian (1999) found that morphological knowledge, that is the knowledge of English affixes and stems, which was intended to be one of the measures for vocabulary depth, did not uniquely and significantly predict reading comprehension.

This study was on adult Chinese- and Korean-speaking learners of English in Canada. Similarly, in Zhang and Koda's (2012) study with 130 adult Chinese-speaking EFL learners, derivational knowledge did not also surface as a unique and significant prediction reading comprehension after controlling for vocabulary knowledge. However, this study found that morphological awareness contributed to L2 vocabulary knowledge directly and indirectly through the mediation of learners' lexical inferencing ability.

A reason for the discrepant findings might be that in those studies which failed to show a significant effect of morphological knowledge, there was more stringent control for lexical knowledge in that the measures also considered other aspects of knowledge in addition to knowledge of word meanings. For example, Zhang and Koda (2012) and Qian (1999) both also considered learners' word association ability. The discrepancy might also be related to learners' learning or developmental stage, given that those in support of a unique effect of morphological knowledge all seemed to focus on young, beginning learners (see, however, Farran et al., 2012 for an exception), whereas those who failed to document that unique effect tended to focus on adult, upper-intermediate/advanced learners. Whichever the reason might be, this issue does warrant further research.

4.1.3 Lexical Processing Efficiency and Reading Comprehension

While it is essential that readers possess diverse linguistic knowledge for text comprehension, comprehension would be hampered if these processes are not automatized. An efficient word recognition process for text comprehension necessitates not only rich knowledge of word but also an ability to process printed words and access their meanings rapidly that is lexical processing or word recognition efficiency. Thus, comprehension requires the orchestration or simultaneous execution of a number of processes (Cain & Barnes, 2017; Perfetti, 1999); yet working memory capacity is limited (Baddeley, 2007). A lack of automatized lower-level processes notably word recognition process would constrain the participation of higher-order processes such as textual inferencing for the effective construction of a mental model. From a lexical perspective, because words are intended for use in the real world, including text reading, knowing a word

should not be simply about an ability to “recognize it in connected speech or in print” and “to access its meaning” but should entail the competence “to do these things within a fraction of a second” (Nagy & Scott, 2000, p. 273).

The Lexical Quality Hypothesis (Perfetti, 2007), and its predecessor the Verbal Efficiency Theory, embodies “a capacity theory of comprehension” (Just & Carpenter, 1992). It underscores high-quality representations of (sub-)lexical features because they are fundamental to the rapid recognition of printed words and word-to-text integration processes. (Sub-)lexical processing efficiency is an essential element of the reading comprehension process (Perfetti & Stafura, 2014). In the L1 English reading literature, particularly studies on school children or developing readers, sight word recognition efficiency and word decoding fluency are critical determinants of reading comprehension (Garcia & Cain, 2014).

Theoretically, the above emphasis on efficient lexical and sub-lexical processing should not pertain to L1 or monolingual readers only. In fact, word recognition efficiency, that is, accurate and rapid recognition of printed words has been recognized as essential to L2 reading comprehension (Grabe, 2009; Koda, 2005). In this study, lexical processing efficiency is defined as rapid visual word recognition and sub-lexical processing efficiency as rapid access to morphological constituents of words.

According to Perfetti’s (1985) Verbal Efficiency theory, which contends that skilled reading depends on the efficiency of lexical processing, an automatic and effortless word identification - efficient process – can preserve more processing resources for higher-level comprehension. Efficiency does not simply entail speed alone, but it is rather about how efficiently a reader identifies the form and meaning components of words in a sentence, which are the basic components of comprehension. Readers who can retrieve meanings they need from each word in a given context are more skillful in reading than those who cannot.

More recently, in his Lexical Quality Hypothesis, Perfetti regarded differences in reading skills as essentially the differences in readers’ lexical quality, which refers to “the extent to which a mental representation of a word specifies its form and meaning

components in a way that is both precise and flexible" (Perfetti, 2007, p. 359). Precision and flexibility in form-meaning correspondence both matter in lexical quality, because one needs to know that "knight and night" (Perfetti, 2007, p. 359) are not the same (i.e., precision), and to understand that "roaming charge" (Perfetti, 2007, p. 359) is a type of fee charged by a mobile company, not a battle-maneuver (i.e., flexibility). Lexical representation is in a continuum from no knowledge to the full, coherent representation of a word that each one varies in terms of what and how much one knows about a word, which consequently leads to individual differences in textual comprehension.

Empirically, however, compared to the L1 reading literature, research that considered fluency-related lexical competences is much less in the literature on L2 English reading; and the existing body of research often approached the issue from diverse perspectives and generated mixed findings. On the one hand, some studies on young ESL learners or bilingual children, like those on monolingual children, considered the contribution of word decoding fluency to reading comprehension. Proctor et al., (2005), for example, found that after oral vocabulary was controlled for, English decoding fluency was not a unique and significant predictor of 135 fourth-grade Spanish-speaking ESL learners' reading comprehension in the US. Yet, in the study of Pasquarella et al. (2012) on adolescent L2 readers of English in Canada, real and pseudoword decoding fluency, after controlling for vocabulary knowledge, significantly predicted reading comprehension.

On the other hand, there were a small number of studies, mostly on foreign language learners of English, that approached the issue of lexical processing efficiency in light of readers' rapid lexical/semantic decision. As part of the NELSON project, Van Gelderen et al. (2004), for example, measured adolescent Dutch-speaking EFL readers' "speed of word recognition" with a lexical decision task, that is, a task that asked learners to decide as fast as they could whether a letter string presented on a computer screen was an existing word. Reaction times (RTs) and accuracy of responses were both recorded. Among the five concurrent predictors of English reading comprehension, only vocabulary knowledge in addition to metacognitive

knowledge uniquely and significantly predicted reading comprehension; a significant, unique effect did not surface of the RTs or the word recognition speed.

Yamashita's (2013) study on Japanese-speaking university EFL learners, on the other hand, found that reading comprehension was significantly predicted by learners' efficiency of "decoding" (judgment on whether a nonce word could be "read as an English word") and lexical meaning access (judgment on whether words in a pair were antonyms) measured with a paper-based, timed Yes/No decision task. Note, however, that Yamashita, unlike Van Gelderen et al. (2004), did not concurrently consider the students' lexical knowledge. It thus remains unclear whether the significant effect identified of the processing efficiency measures would remain, had a lexical knowledge measure been included.

4.1.4 Sub-lexical/Morphological Processing Efficiency and Reading Comprehension

To date, very little research has aimed to test whether sub-lexical processing efficiency, particularly morphological processing efficiency, would be a dimension of lexical competence that may uniquely predict L2 reading comprehension, along with other dimensions lexical versus sub-lexical/morphological knowledge, on the one hand, and their processing efficiency, on the other. Overall, despite increasing interests in morphological knowledge and L2 reading comprehension (e.g., Zhang, 2017; Zhang & Koda, 2012), few studies have examined L2 morphological processing (e.g., Clahsen, Felser, Neubauer, Sato & Silva, 2010).

Clahsen et al. (2010) summarized some studies that examine three domains of morphological processing (regular and irregular inflection, derived word forms, and morphosyntactic phenomena) in advanced adult second language learners. They concluded that there are clear differences between native and non-native processing in all three domains, indicating that adult L2 learners are less sensitive to morphological structure than native speakers and rely more on lexical storage than on morphological parsing during processing.

However, little effort aimed to combine the two lines of research and examine how morphological processing efficiency may have a unique role to play during text

reading. Logic suggests that if morphological knowledge is important for lexical inferencing and/or word decoding fluency during text comprehension, as some L2 studies suggested (e.g., Zhang, 2017; Zhang & Koda, 2012), the unitization of or access to this knowledge must be in a rapid manner for comprehension to be smooth and efficient. Zhang and Ke (2020) underscored the importance of morphological decoding fluency in L2 reading comprehension. If efficient morphological processing, which entails quick access to morphological features such as morphological structure and meanings of morphemic constituents, is not in place, fluent morphological decoding would not be possible. In other words, morphological knowledge is necessary but insufficient for efficient processing or recognition of multimorphemic words in print. Empirically, as in the case of lexical knowledge versus its processing efficiency, it is warranted to study morphological processing efficiency in conjunction with morphological knowledge to explore their hypothetically unique contribution to L2 reading comprehension.

4.2 The Present Study

The above theoretical discussion and review of empirical shreds of evidence suggested that lexical and sub-lexical/morphological knowledge as well as their corresponding processing efficiency should all be functional in L2 text reading. Yet not all lexical competences have received adequate attention in the literature, notably (sub-)lexical processing efficiency. More importantly, little research has concurrently considered these lexical competences – lexical vs. sub-lexical on the one hand and knowledge vs. processing efficiency on the other – and compared how they collectively and relatively predict L2 reading comprehension. Finally, little research has studied those issues in adult Arabic-speaking EFL readers as opposed to young Arabic-English bilingual children in North America.

This study thus aims to address these gaps and explore the lexical basis of L2 reading comprehension in light of the Lexical Quality Hypothesis. The overarching question to be answered is: How do distinct lexical competences collectively and relatively predict L2 reading comprehension? Three sets of questions are further posed to guide this study. The first set examines the contribution of lexical level vs. morphological of lexical knowledge predictors; the second set the contribution of

knowledge vs. processing efficiency predictors; and the last one the collective and relative contributions of the four lexical competences.

1. How does lexical vs. sub-lexical knowledge on the one hand, and lexical vs. sub-lexical processing efficiency on the other, relatively predict L2 reading comprehension? How does lexical-level competence (knowledge and processing efficiency) vs. sub-lexical competence (knowledge and processing efficiency) relatively predict L2 reading comprehension?

2. How does lexical knowledge vs. processing efficiency on the one hand, and sub-lexical knowledge vs. processing efficiency on the other, relatively predict L2 reading comprehension? How does knowledge (lexical and sub-lexical) vs. processing efficiency (lexical and sub-lexical) relatively predict L2 reading comprehension?

3. How do the four lexical competences – lexical and sub-lexical on the one hand and knowledge and processing efficiency on the other – collectively and relatively predict L2 reading comprehension?

4.3 Method

4.3.1 Participants

The participants were 268 Arabic-speaking first-year students from a university in Saudi Arabia, that is Taif university. Later, only 220 participants were included in final analysis for the current study as a result of excluding forty-eight cases from this study's data analysis because missing some of the tests that are related to this study. In other words, a participant who did not complete all tests was removed from the dataset. The age of the participants ranged between 17 and 22 years old (mean age = 20 years old). They represented a range of undergraduate majors offered by the Taif university, including, for example, Media, Chemistry, Nutrition, and Computer Science. They all participated on a voluntary basis (for details see Participants section 3.3, Chapter 3).

4.3.2 Measures

Data was collected by administrating a battery of paper- and computer-based tests on a group or individual basis. These tests measure the participants' distinct lexical competences (i.e., lexical and sub-lexical knowledge tests, lexical processing

efficiency (i.e., lexical decision task), and sub-lexical processing skills tests, reading comprehension, as well as working memory capacity (see Figure 4.1).

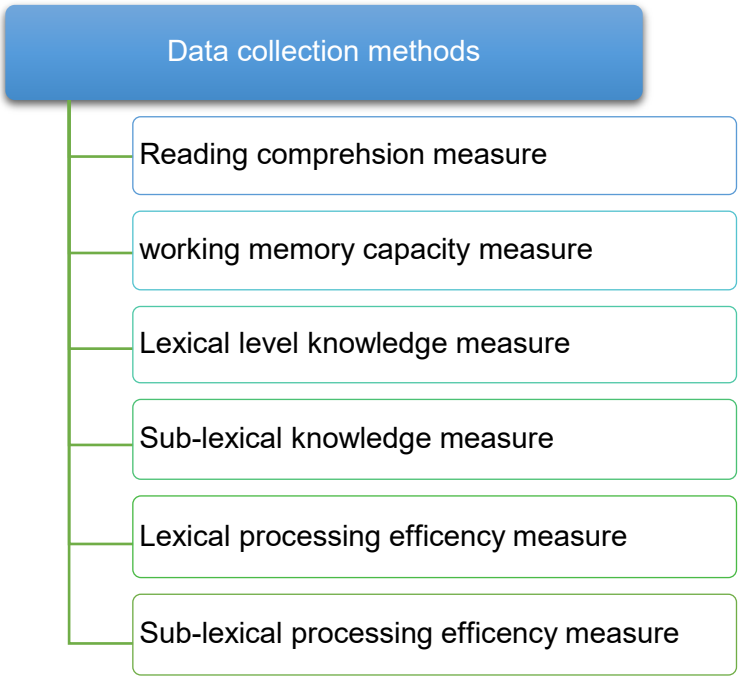

Figure: 4.1 Study 1 data collection methods

Reading Comprehension Measure. Reading comprehension measure was employed in both studies of this research as the dependent variable. It was measured using a standardized reading test, namely, Gates-MacGinitie Reading Tests, Fourth Edition (Form S) (MacGinitie, MacGinitie & Maria, 2000). This test was selected because it considers different types of texts and assesses literal as well as inferential comprehension with separate questions. Another consideration was that this test, as opposed to any standardized tests that target non-native speakers of English (e.g., IELTS), would not likely have been taken by a participant of this study. Four short reading passages were selected with a mean length of about 120 words from Level 5, based on the researcher's expert knowledge about local students' reading proficiency. Deliberately, of the four passages selected, two were informational and the other two narratives, so as to have a better representation of text types. Each passage was accompanied by five or six multiple-choice questions, with a total of 21 questions across the four passages. These questions were picked

to evenly ask about the two types of comprehension: the literal and the inferential, with ten items and 11 items, respectively.

This test was paper-based and administrated in two class sessions, two passages in each session, and each session about 25 minutes. Participants were instructed to read the passages silently and circle an answer for each multiple-choice question. Two different methods were adopted to deal with missing data. For those who sat in for both sessions, a missing response was coded missing and received zero points. For the small number of cases who participated in one of the two sessions and missed the other because of absence from class, it would not make sense to score any missing responses that resulted from a missed session as zero. Consequently, due to their "incomplete data," those cases were coded as missing for reading comprehension in the dataset.

The maximum score possible was 21 for this test. The internal consistency of this measure was assessed using Cronbach's α value of internal consistency, and it was .630. Although this value is lower than .7, it is still considered an acceptable value. The test is not included in the appendices section because it is a copyrighted material.

Vocabulary Knowledge Measure. In both studies, lexical-level knowledge, as termed in study 1, and vocabulary size knowledge as termed in study 2 was narrowly defined as learners' knowledge of meanings of individual words or form-meaning connection. This kind of knowledge was assessed and included in the analysis of both studies. In study 1, it represents one of the core lexical competences that was assessed comparing to other lexical knowledge aspects. On the other hand, it was also included in study 2 analysis as a covariate to examine the role of two components of word-to-text integration over and beyond it. In literature, the form-meaning connection of words has been measured differently in several prior studies. One of the well-known measures of vocabulary size in the literature is the Vocabulary Levels Test (VLT) (Nation, 1983; Schmitt, Schmitt, Clapham, 2001). It has also been widely applied for measuring vocabulary size in adult EFL readers in applied linguistics and demonstrated very high reliability.

The VLT was first introduced in the early 1980s and has since been modified and revised (Beglar & Hunt 1999; Nation 1990; Schmitt et al. 2001). It has been developed to a new version to address some limitations of the old versions by Schmitt et al. (2001). The new version assesses the form-meaning connection of lexical knowledge at five-word frequency levels: 1000, 2000, 3000, 4000, and 5000. These levels present vocabulary at levels of great value to the majority of L2 learners (Webb & Sasao, 2013). It also uses the same matching format as the earlier versions of the VLT and includes ten clusters that measure knowledge of 30 items at each level. Fifteen items at each level are nouns, nine items are verbs, and six items are adjectives. Test takers need to match three words from six options to their definitions in each cluster. An adapted example of the instructions and example item for VLT from Schmitt et al. (2001) is presented as follows.

You must choose the right word to go with each meaning. Write the number of the word next to its meaning.

1. bench ____ long seat
2. charity ____ help to the poor
3. mate ____ part of a country
4. jar
5. mirror
6. province

The VLT has been proved to be a highly valid and reliable test for measuring vocabulary size, and therefore was adopted for the present research. The VLT version that was employed for the present research was modified by the researcher in the current research considering the study's participants and the study's goals. Only four levels of word frequency: 1000, 2000, 3000, and 5000 were included. For each frequency level, six items were carefully selected from Schmitt et al. (2001) VLT and randomly sampled. Each item consists of a list of six words and three meaning choices from each level with a total of 18 items in each level, and merely a total of 72 items in all the four levels was chosen. Furthermore, different from the original VLT, the three meaning choices were translated and presented in the Arabic language. Participants were asked to select only one explanation to match each

word's meaning choice (see Appendix 6). The VLT measure was administered in one class session, and participants were given 20 minutes to complete it. The maximum score was 72 for this test. The Cronbach's α value was .949.

Sub-lexical Knowledge Measures. Learners' sub-lexical knowledge was particularly interested in that pertains to morphology or more specifically derivation. Morphology is a "constituent binding mechanism" for orthography, phonology, semantics, and grammar in the Lexical Quality Hypothesis (Perfetti, 2007). Participants' morphological knowledge was measured with a researcher-developed task modeled on the Word Part Levels Test (Sasao & Webb, 2017). While the format of the original test, the instructions, and the scoring method were the same, some items were redesigned with consideration of the local students' English learning experience and knowledge of English prefixes and suffixes. The test consisted of the following three sections, assessing the knowledge of form, meaning, and use of English affixes (e.g., *-less* and *super-*), respectively.

The first section consisted of 12 items that measured the knowledge of the correct written form of common English prefixes and suffixes. Participants were presented with four orthographically resembling options, only one of which was a correct affix and should thus be circled. The second section, which consisted of 10 items, measured the knowledge of meanings of affixes. Participants were asked to select a simple English word, out of four choices, that conveys the meaning of a target prefix or suffix. For each affix, such as *un-*, two of the most common words that involve that affix were given as examples (e.g., *unhappy* and *unfair*) to contextualize its use; additionally, the Arabic translation of the four English word choices (e.g., for *un-*: *again*, *no*, *back*, and *new*) was also provided. Finally, the last section, which included 10 items, measured the knowledge of how an affix indicates the part-of-speech of a derivational word (i.e., the syntactic properties of affixes). For each item, a prefix or suffix (e.g., *-ish*) was presented together with a derivational word (e.g., *selfish*) to show its use. Participants were asked to select noun, verb, adjective, or adverb to demonstrate an understanding of how the target affix indicates the part-of-speech of a word to which it is attached. The Arabic translation of the words

“noun,” “verb,” “adjective,” and “adverb” was also provided (see Appendix 7). The total of the items of this test was 32.

The test with its three sections was administered in a paper version to the participants in a separate class session of about 20 minutes. To know more about the paper-based testing procedure and scoring, further details were offered in Chapter 3. The maximum score possible for the three sections of the morphological knowledge test was 12, 10, and 10, respectively. The Cronbach’s α of the three sections was .755, .747, and .661, respectively. These values reflect acceptable internal consistency values of the measure’s section.

Lexical Processing Efficiency Measure. While the lexical knowledge measure described earlier aims to assess how many words one knows or vocabulary size, lexical processing efficiency, in the context of this study, is about visual word recognition efficiency, that is, how rapidly learners can recognize a printed word that they know. To measure lexical processing efficiency, a computer-based lexical decision task, which was also used in Van Gelderen et al. (2004), was adopted.

The lexical decision task consisted of 40 real words as well as 20 pseudowords as fillers. The real words were randomly selected from the 1000 level of the most frequent words in English Corpus of Contemporary American English (COCA) and should thus be known to the participants (see Appendix 8). The rationale for only choosing words from the most common group of words in English is to assure they are well-known to the participants and then the measure assesses the time they need to access knowledge they already have. The order of those real words and pseudowords was randomized and they were presented to the participants one by one on the computer’s screen. Participants were asked to indicate whether they knew a word on the screen by pressing as quickly as possible the “yes” or “no” key marked on the keyboard. Both RTs and Yes/No responses were recorded. For computing RTs, only correct responses were considered. Details on the testing procedure and scoring are provided in Chapter 3, sections 3.4, 3.6, and 3.7, specifically, the Data Collection Procedure section. The Cronbach’s α, based on the accuracy of responses, was .891.

Sub-lexical Processing Efficiency Measures. The sub-lexical processing efficiency measure focused on morphological processing. Two computer-based tasks were included. In the separability task, following Koda (2000), participants were asked to decide, as quickly as possible, whether a word presented in the center of the computer's screen can be separated into two or more meaningful components (i.e., stems and affixes). There were 30 stimulus words that had been learned by the participants. Fifteen were actual derivational words, such as *government* and *disappear*, which can be segmented into *govern* and *-ment*, and *dis-* and *appear*, respectively. The other 15 words were monomorphemic words that included a letter or a string of letters resembling an English affix, such as *pow<u>er</u>* and *kitch<u>en</u>*. Conversely, the combinability task asked the participants to decide, as quickly as possible, whether the two-word parts presented on the computer's screen can be combined to make a meaningful "bigger" English word. There were 24 items in this task, including 12 items that were combinable, such as *fear* and *less*, and 12 items that were not (e.g., *un* and *home*) (see Appendix 9). The Cronbach's α of these two tasks was .808 and .620, respectively.

Working Memory Measure. Text comprehension necessitates the execution of some processes, the efficiency of which depends heavily on readers' mental capacity (Just & Carpenter, 1992). Working memory capacity, in particular, is a significant correlate of L2 reading comprehension (Grabe, 2009; Harrington & Sawyer, 1992). Other processing skills, such as lexical processing, depend on working memory capacity (Tokowicz, 2014). Subsequently, to obtain a more accurate understanding of the effect of the lexical competences, particularly that of processing efficiency, learners' working memory had to be measured and later included as a covariate in regression analysis in both studies when L2 reading comprehension was predicted by different lexical competences in study 1, and by different components of word-to-text integration in study 2.

Working memory capacity was measured with a computerized simple digital span task, which is one of the most widely used tests to assess working memory capacity (Richardson, 2007). Simple short-term storage capacity is measured in literature with a number of unrelated *digits* or *words* that can be recalled (Juffs & Harrington, 2011).

However, the digit span measure, compared to the word span measure, was considered to be more suitable for measuring the capacity of working memory of L2 readers, because it would not be confounded by such factors as the test takers' familiarity with the words (Harrington & Sawyer, 1992).

The working memory measure consisted of 20 numerical sequences – ten for forwarding span and ten backward span – assessing short-term storage of the stimulus sequences (Kane, Hambrick & Conway, 2005). For the forward span items, participants were asked to decide, as quickly as possible, whether a digit sequence presented on the computer screen was the one they saw earlier and in the given order. Likewise, for the backward span items, they were to decide whether a digit sequence presented on the screen was the one that they saw earlier but had the order reversed. For both types of the span, there were five sets of random numerical digits increasing in number or length of sequence started with two-digit sequences and ended with six-digit sequences. Each set consisted of two items: one with the order matched and the other with the wrong order (see Appendix 10). The participants began the test by seeing a digit sequence appear in the center of the computer screen for a fixed rate of 1000 milliseconds. Upon the offset of the stimulus sequence, a question, "Is this (a digit sequence matching or not matching the stimulus sequence in order) the number you saw in the given order" (or, "in the reverse order" for the backward span items), appeared on the screen. The Cronbach's α was .754 based on the accuracy of responses.

4.4 Results

4.4.1 Descriptive Statistics and Reliabilities

The means, standard deviations, reliabilities (Cronbach's α), and skewness and kurtosis values of all measured competences are presented in Table 4.1 Overall, the tasks all had very good internal consistency reliability; the reliability of the reading comprehension measure and the third sub-lexical knowledge task (i.e., syntactic properties of affixes) was relatively low but adequate or acceptable. The accuracy rate and RTs are both shown for the (sub-)lexical processing efficiency measures, although for the reason that was mentioned earlier only IESs were used for the subsequent bivariate correlation and regression analyses. The skewness and

kurtosis estimates were generally below the rule-of-thumb values for univariate normality (i.e., ±2 for both skewness and kurtosis) as well as the critical values that may result in a significant deviation from multivariate normality (i.e., ±2 and ±7 for skewness and kurtosis, respectively; Curran, West & Finch, 1996).

Table 4.1

Measures and Descriptive Statistics of the First study

	N	M	SD	Rel. (α)	Skewness		Kurtosis	
					Statistics	SE	Statistics	SE
Reading Comprehension	21	8.15	3.47	.630	.479	.154	-.161	.306
Affix Form	12	7.78	2.92	.755	-.370	-.152	-.603	.303
Affix Meaning	10	6.29	2.57	.747	-.392	.152	-.638	.303
Affix Function	10	4.41	2.47	.661	-.696	.153	-.102	.306
Separability (accuracy)	30	18.44	5.62	.812	-.525	.151	-.203	.302
Separability (raw RT)	–	1580.7	343.2	–	-.593	.152	1.126	.302
Combinability (accuracy)	24	14.01	3.99	.684	.087	.153	-.424	.304
Combinability (raw RT)	–	1966.5	423.7	–	-.829	.151	1.038	.302
Vocabulary Levels	72	38.10	14.58	.949	.320	.151	-.490	.300
Lexical Decision (accuracy)	40	30.27	7.73	.904	-.882	.151	.182	.301
Lexical Decision (raw RT)	–	973.95	186.5	–	-.298	.151	.050	.301
Working Memory (accuracy)	20	14.02	3.73	.754	-1.110	.151	1.740	.300
Working Memory (raw RT)	_	1988.3	320.7	_	-.079	.152	-.046	.302

*Note*s. N = number of items; M = mean; *SD* = standard deviation; Rel. (α) = Reliability (Cronbach's alpha); SE = standard error; RT = reaction time. Affix form, affix meaning, and affix function = sub-lexical knowledge; separability and combinability = sub-lexical processing; Vocabulary levels = lexical knowledge; lexical decision = lexical processing.

4.4.2 Bivariate Correlations

Table 4.2 shows the bivariate correlations between all the variables. To highlight, reading comprehension correlated positively and significantly with all knowledge variables. The correlation between lexical knowledge and reading comprehension was significant and moderate in size (r = .643, p < .001). Compared to other variables in Table 4.2, this correlation is also the highest, which suggests lexical knowledge as the strongest correlate of reading comprehension. Reading comprehension also correlated negatively and significantly with working memory (r = -.169, p < .05) and the two sub-lexical processing efficiency tasks (rs = -.183 and -.193; both ps < .01). The correlation between reading comprehension and lexical processing efficiency was negative as well (r = -.084, p = .213); however, it did not achieve the significance level. These negative correlations between these variables and reading comprehension show that better reading comprehension is related to faster identification of these variables.

It is also important to note that the three measures of morphological knowledge were all significantly correlated with each other. Knowledge of affix forms significantly correlated with knowledge of affix meanings (r = .463, p < .001) and knowledge of affix function (r = .506, p < .001); and knowledge of affix meaning and knowledge of affix function also showed a significant correlation (r = .518, p < .001). All three morphological knowledge measures also significantly correlated with lexical knowledge, r = .405, r = .447, and r = .557 (all ps < .001), respectively, for the affix knowledge, meaning, and function tasks.

Finally, all the (sub-)lexical knowledge measures negative and significantly correlated with all the (sub-)lexical processing efficiency measures. The two morphological processing efficiency measures and working memory were also positively and significantly correlated. The correlation between lexical processing efficiency and working memory was also positive but not statistically significant (r = .087, p = .197).

Table 4.2

Bivariate Correlations Between All Measured Competences of the First Study

		1	2	3	4	5	6	7	8	9
1	Reading Comprehension	_								
2	Affix Form	.391***	_							
3	Affix Meaning	.369***	.463***	_						
4	Affix Function	.519***	.506***	.518***	_					
5	Separability	-.183**	-.254***	-.305***	-.291***	_				
6	Combinability	-.193**	-.220**	-.294***	-.331***	.369***	_			
7	Vocabulary Levels	.643***	.405***	.447***	.547***	-.193**	-.206**	_		
8	Lexical Decision	-.084	-.137*	-.228***	-.218***	.247***	.273***	-.227**	_	
9	Working Memory	-.169*	-.182**	-.266***	-.176**	.202**	.144*	-.207**	.087	_

***p* < .05, ****p* < .01, *****p* < .001**

***Notes*. Affix form, affix meaning, and affix function = sub-lexical knowledge; separability and combinability = sub-lexical processing; Vocabulary levels r= lexical knowledge; lexical decision = lexical processing.**

4.4.3 Contribution of Lexical Competences to Reading Comprehension

A series of hierarchical regression analyses were performed to examine how different dimensions of lexical competences – lexical vs. sub-lexical; knowledge vs. processing efficiency – collectively and relatively contributed to L2 reading comprehension over and above working memory. For all analyses, working memory was entered first into the regression equation as a covariate (it explained about 2.9% of the variance in reading comprehension), followed by different lexical competences entered individually or as a block. The three morphological knowledge measures were always entered as a block; likewise, the RTs for the morphological separability and combinability tasks were also entered as a block to represent morphological processing efficiency. The order of entry was also switched for different predictors to test, and compare, their unique contribution to reading comprehension.

4.4.4 Comparing Lexical and Morphological Predictors

The first research question sought to compare lexical and morphological predictors of reading comprehension. Three sets of regression analyses were conducted for this purpose. First, it was examined how lexical knowledge and morphological knowledge predictors relatively contributed to reading comprehension; and then analyzed how lexical processing efficiency and morphological processing efficiency relatively contributed to reading comprehension. Finally, it was compared to how the two lexical-level competences (i.e., knowledge and processing efficiency collectively) and the two morphological competences (also knowledge and processing efficiency collectively) relatively predicted reading comprehension.

As shown in the upper panel of Table 4.3, after controlling for working memory, lexical knowledge additionally explained 38.6% of the variance in reading comprehension ($p < .001$). Over and above working memory and lexical knowledge, morphological knowledge also significantly predicted reading comprehension ($p = .001$); it, however, only additionally explained 4.4% of the variance. When morphological knowledge was entered into the regression equation as the second step, it added 27.1% to the variance explained ($p < .001$). The unique effect of lexical knowledge remained significant; over and above working memory and morphological knowledge, it additionally explained 15.9% of the variance in reading comprehension. It can thus be concluded that lexical knowledge explained a far greater amount of unique variance than did morphological knowledge, although the unique effect of both predictors was significant.

The middle panel of Table 4.3 shows the unique contribution of lexical vs. morphological processing efficiency. After controlling for working memory, lexical processing efficiency did not predict reading comprehension significantly, whether it was entered before or after morphological processing efficiency. It barely explained any additional variance in reading comprehension when morphological processing efficiency was already in the model. On the other hand, morphological lexical processing efficiency uniquely explained a small yet significant proportion of variance in reading comprehension. Specifically, with working memory and lexical

processing efficiency were in the regression model, morphological lexical processing efficiency additionally explained 3.4% of the variance (p = .021).

Lastly, it was compared to the effects of the two lexical predictors with those of the two morphological predictors. As shown in the bottom panel of Table 4.3, the lexical predictors (knowledge and processing entered as a block) had a far greater unique effect on reading comprehension than did the morphological predictors, although the unique effect of both was significant. Specifically, over and above working memory and the lexical predictors, the morphological predictors additionally explained about 4.9% of the variance in reading comprehension (p = .002). On the other hand, the lexical predictors, when entered into the regression model at the last step, significantly explained about 16.7% of the variance in reading comprehension (p < .001).

Taken together, the findings suggested that lexical-level competences overall had a stronger effect on reading comprehension than did morphological competences; and this advantage seemed to be attributed to the large effect of lexical knowledge. With respect to processing efficiency, the effect at the morphological level, though small, was actually greater.

Table 4.3

Comparing Lexical and Morphological Predictors of Reading Comprehension

Steps	Predictors	R^2	Adjusted R^2	ΔR^2	P
1	Working memory	.029	.024	.029	.012
Lexical vs. Morphological knowledge					
2	Lexical knowledge	.414	.409	.386	.000
3	Morphological knowledge	.459	.446	.044	.001
2	Morphological knowledge	.300	.287	.271	.000
3	Lexical knowledge	.459	.446	.159	.000
Lexical vs. morphological processing					

2	Lexical processing	.034	.025	.005	.297
3	Morphological processing	.068	.050	.034	.021
2	Morphological processing	.067	.055	.039	.012
3	Lexical processing	.068	.050	.000	.876
Lexical vs. morphological (knowledge & processing)					
2	Lexical knowledge & processing	.419	.411	.390	.000
3	Morphological knowledge & processing	.467	.447	.049	.002
2	Morphological knowledge & processing	.300	.280	.271	.000
3	Lexical knowledge & processing	.467	.447	.167	.000

4.4.5 Comparing Knowledge and Processing Efficiency Predictors

The second research question aimed to compare the effects of knowledge and processing efficiency predictors. Three sets of regression analyses again were conducted. First, it was compared these two types of competence at the lexical level, and then at the sub-lexical level. Lastly, it was compared to the effects of lexical and morphological knowledge (i.e., the two levels together) and those of lexical and morphological processing efficiency.

The upper panel of Table 4.4 shows the results of the first comparison. Controlling for working memory and lexical processing efficiency, lexical knowledge significantly explained a unique proportion of variance in reading comprehension (about 38.5%; $p < .001$). Conversely, however, a unique effect did not surface for lexical processing efficiency when it was entered lastly into the model ($p = 0.214$); and minimal additional variance was explained of reading comprehension ($\Delta R^2 = .004$).

The middle panel of Table 4.4 presents the results of the second comparison. Morphological knowledge, whether entered in the model before and after

morphological processing efficiency, significantly predicted reading comprehension (both *p*s < .001). As the last predictor entered in the model, morphological knowledge uniquely explained about 23.2% of the variance of reading comprehension. Conversely, although controlling for working memory, morphological processing efficiency significantly predicted reading comprehension (ΔR^2 =.039, p = .012), it failed to significantly predict reading comprehension when morphological knowledge was also in the model (ΔR^2= 0.000, p = 0.997).

Finally, as shown in the bottom panel of Table 4.4, the two knowledge measures (lexical and morphological combined) collectively and uniquely explained about 40% of the variance in reading comprehension (p < .001) when working memory and the two processing efficiency measures (lexical and morphological) were also in the model. Conversely, entered after working memory and the two knowledge predictors, the two processing efficiency measures, however, barely explained any additional variance in reading comprehension (ΔR^2 = .009, p =.341).

Taken together, the above findings seem to suggest clearly that knowledge was a far stronger predictor of reading comprehension than processing efficiency, which was true for both the lexical and the morphological level or disregarding the level of competence.

Table 4.4

Comparing Knowledge and Processing Efficiency Predictors of Reading Comprehension

Steps	Predictors	R^2	Adjusted R^2	ΔR^2	*P*
1	working memory	.029	.024	.029	.012
Lexical knowledge vs. Lexical processing					
2	Lexical knowledge	.414	.409	.386	.000
3	Lexical processing	.419	.411	.004	.214
2	Lexical processing	.034	.025	.005	.297
3	Lexical knowledge	.419	.411	.385	.000

Morphological knowledge vs. Morphological processing					
2	Morphological knowledge	.300	.287	.271	.000
3	Morphological processing	.300	.280	.000	.997
2	Morphological processing	.067	.055	.039	.012
3	Morphological knowledge	.300	.280	.232	.000
Knowledge vs. processing (lexical & morphological)					
2	Lexical & morphological knowledge	.459	.446	.430	.000
3	Lexical & morphological processing	.467	.447	.009	.341
2	Lexical & morphological processing	.068	.050	.039	.032
3	Lexical & morphological knowledge	.467	.447	.400	.000

4.4.6 Unique Contribution of Each Predictor

Distinct from the first two questions, the last research question focused on the unique and relative contribution of each predictor. Table 4.5 shows that the four lexical competences collectively explained over 40% of the variance in reading comprehension. The top section of the table shows the results on the unique contribution of morphological knowledge, and morphological processing efficiency when all the other predictors (working memory included) were in the model. The unique contribution was significant for morphological knowledge (ΔR^2= .040, p = .001), but not for morphological processing efficiency (ΔR^2= .001, p = 0.866). Likewise, the bottom section of Table 4.5 shows the unique contribution of lexical knowledge, and lexical processing efficiency, when all the other predictors were in the model. The unique contribution of lexical knowledge was significant (ΔR^2= .165, p < .001); yet a significant, unique effect did not surface of lexical processing efficiency (ΔR^2= .008; p = .068).

Taken together, it is clear from the unique proportion of variance explained of reading comprehension (i.e., ΔR^2), lexical knowledge was the strongest unique predictor, followed by morphological knowledge. With the presence of the knowledge predictors and working memory in the model, lexical and morphological processing efficiency barely contributed to reading comprehension.

Table 4.5

The Unique Contribution of Each Predictor of Reading Comprehension

Steps	Predictors	R^2	Adjusted R^2	ΔR^2	*P*
1	working memory	.029	.024	.029	.012
The unique contribution of morphological knowledge vs. processing					
2	Lexical knowledge	.414	.409	.386	.000
3	Lexical processing	.419	.411	.004	.214
4	Morphological processing	.427	.413	.008	.219
5	Morphological knowledge	.467	.447	.040	.001
4	Morphological knowledge	.467	.452	.048	.000
5	Morphological processing	.467	.447	.001	.866
The unique contribution of lexical knowledge vs. processing					
2	Morphological knowledge	.300	.287	.271	.000
3	Morphological processing	.300	.280	.000	.997
4	Lexical processing	.302	.279	.002	.413
5	Lexical knowledge	.467	.447	.165	.000
4	Lexical knowledge	.459	.441	.159	.000
5	Lexical processing	.467	.447	.008	.068

4.5 Discussion

The present study set out to investigate how four distinct dimensions of lexical competence – lexical vs. morphological on the one hand and knowledge vs.

processing efficiency on the other – collectively and relatively contributed to reading comprehension in adult learners of English so as to shed light on the lexical basis of L2 reading comprehension. To answer the research questions, the four lexical competences collectively explained over 40% of the variance in the participants' reading comprehension. Compared to the processing efficiency predictors, the knowledge predictors had a predominant influence on reading comprehension. In fact, when the effects of the knowledge predictors were taken into consideration, those of the processing efficiency predictors were no longer significant. Additionally, the lexical predictors collectively had a greater effect on reading comprehension than did the morphological predictors; yet, this overall effect did not seem to hold specifically for processing efficiency in that morphological processing efficiency seemed to have a larger effect on reading comprehension (nonetheless, the effect of both processing efficiency predictors was very small). Finally, among the four lexical competences, lexical knowledge was the strongest predictor, followed by morphological knowledge and processing efficiency predictors.

4.5.1 Lexical vs. Morphological Knowledge in Reading Comprehension

The Lexical Quality Hypothesis (Perfetti, 2007) contends that high-quality representations of lexical and morphological features are fundamentally important for text comprehension. The lexical basis of reading comprehension it underscores (Perfetti & Hart, 2001) has been largely supported in the L2 (as well as L1) reading comprehension literature. Notably, a strong association has been consistently found between vocabulary knowledge and reading comprehension (Choi & Zhang, 2018; Grabe, 2009; Jeon & Yamashita, 2014). This relationship was replicated in the present study. The lexical knowledge measure, which targeted vocabulary size, explained nearly 40% of the variance in reading comprehension (when the effects of working memory and morphological knowledge were concurrently considered; see Table 4.4). Considering that the previous findings were derived largely from speakers of languages other than Arabic (e.g., Japanese, Chinese, Spanish), the present finding seems to suggest that disregarding learners' L1 background, lexical knowledge, or knowledge of word meanings is fundamentally important for L2 reading comprehension.

An issue under-studied in the literature pertains to the (unique) importance of knowledge of morphological features encapsulated in the Lexical Quality Hypothesis. In the present study, the focus was on morphological features, because morphology serves to bind other morphological features, including orthography, phonology, semantics, and grammar (Kirby & Bowers, 2017). In fact, this study attended to several aspects of morphological knowledge that touched on orthography (the affix form measure), semantics (the affix meaning measure), and grammar (the affix function measure). In the L2 literature, despite an increasing interest in the role of morphology in reading comprehension, the attention is overall limited, and most existing studies focused on young EFL learners or bilingual children (e.g., Kieffer & Lesaux, 2008; Zhang, 2017; Zhang & Koda, 2013). Few studies have attended to this issue in adult learners of English (see Zhang & Koda, 2012, for an exception). In the present study, which focused on adult Arabic-speaking EFL learners, it was found all three measures of morphological knowledge significantly correlated with reading comprehension; and collectively, they significantly predicted reading comprehension over and above lexical knowledge (i.e., vocabulary size), even though the unique effect was much smaller than that of lexical knowledge (see Table 4.3). This finding thus lends support to the highlight of the Lexical Quality Hypothesis on the importance of morphological representations for text comprehension.

The finding also suggests that morphological knowledge is uniquely important for reading comprehension independent of lexical knowledge in adult learners of English. Yet, it seems to differ from the findings of two previous studies that also focused on adult learners. Zhang and Koda (2012), for example, found morphological knowledge only indirectly contributed to reading comprehension through vocabulary knowledge; when vocabulary knowledge was controlled for, the effect of morphological knowledge was not significant. Likewise, Qian (1999) did not report a unique and significant effect of the morphological knowledge predictor, which was intended to measure an aspect of vocabulary depth knowledge.

One reason for the discrepancy of findings might be that the lexical/vocabulary measures in both Zhang and Koda (2012) and Qian (1999) considered aspects of

knowledge beyond that of individual word meanings. Specifically, both studies, in addition to vocabulary size (measured with a Vocabulary Levels Test), concurrently considered word association ability as a vocabulary depth measure, which was not the case in our study. Another reason might be, in contrast to the two previous studies, that our study had a more comprehensive consideration for aspects of morphological knowledge, including form, meaning, as well as function. Notably, the affix function task, which targeted learners' knowledge of the syntactic properties or part-of-speech information of derivational affixes, had the highest correlation with reading comprehension in this study (r = .519, p < .001; see Table 4.2). This aspect of knowledge, which was not specifically considered in the two previous studies, is particularly underscored by Nagy (2007) as contributive to sentence parsing and reading comprehension.

Whichever the reason might be, the above discussion suggests that morphological knowledge overall should be an important underpinning of reading comprehension (see also the size of correlation reported in Jeon & Yamashita, 2014). Yet, whether a unique effect can emerge, over and beyond lexical knowledge, may depend on what aspects of morphological knowledge are the focus on the one hand and what aspects of knowledge at the lexical level are the concurrent focus on the other. This issue warrants further research.

4.5.2 (Sub-)Lexical Processing Efficiency in Reading Comprehension

The processing efficiency measures generated a few very intriguing findings. To begin with, overall, when working memory and the two knowledge predictors were concurrently in the model, neither lexical nor morphological processing efficiency predicted reading comprehension significantly. This was a surprising finding, because, theoretically, for smooth text comprehension to happen, efficient word recognition and word-to-text integration are essential (Perfetti, 2007). In other words, text comprehension necessitates not only rich knowledge of word meanings and morphological features, but also an ability to process printed words, including multimorphemic words efficiently, and access their meanings during text comprehension. The ability to quickly recognize a word (and word parts) or the ease of accessing word knowledge should have an added value to reading

comprehension (Nagy & Scott, 2000; Perfetti & Hart, 2001). Automatized lower-level processing skills are essential to enable effective participation of higher-order processes for constructing mental models during text reading. This is in line with a capacity view of discourse comprehension (Just & Carpenter, 1992), and should pertain to any readers of English, whether English is their native or second language (Grabe, 2009; Koda, 2005).

One interpretation for the lack of a unique and significant effect of the processing efficiency measures, as it was speculated, is that this finding may reflect what characterizes lexical involvement at the developmental stage of our participants. Although the students had learned English for at least six years (in a foreign language context), their English proficiency tended to below. This can be partly seen from their low performance on the reading comprehension measure (the average score was about eight out of 21 items; see Table 4.1): Level 5 of the Gates-MacGinitie Reading Tests, from which the passages and questions were sampled, actually targets 5th graders in an English-speaking context. In other words, for the participants to comprehend the passages, knowledge of word meaning (and knowledge of morphemic meanings for morphologically complex words) should reasonably be a dominant influence. In the L1 reading literature at least, less-skilled comprehenders, compared to skilled comprehenders, tended to have problems with word processing or show less immediate use of word meanings in the integration process (Nation & Snowling, 2004; Perfetti & Stafura, 2014).

Another factor for attention might be that the comprehension test was not administered in a timed condition. Although the students were asked to complete a test session within a specified period of time, that is, 10-15 minutes per passage, this time restriction might be too relaxed (considering that each passage was only about 120 words long and followed by only five questions) for processing efficiency to make a noticeable difference, particularly when individual differences in working memory were also taken into account. On the other hand, the present finding seemed to corroborate those from the NELSON project on adolescent learners of English in the Netherland (e.g., Fukkink, Hulstijn & Simis, 2005; Van Gelderen et al., 2004). In those studies, word recognition speed was not found to predict reading

comprehension uniquely and significantly; additionally, while word recognition training did improve word recognition speed, the effect did not transfer to benefit reading comprehension.

Despite the weak unique effects of the two processing efficiency predictors, their relative contribution shown in Table 4.3 deserves some attention. Specifically, when lexical processing efficiency was controlled for, sub-lexical processing efficiency had a significant, albeit small, effect on reading comprehension; conversely, however, this significant effect did not surface for lexical processing. It was speculated that this gap might be attributed to two reasons. First, compared to the morphological processing tasks, the participants seemed to respond much faster in the lexical decision task. As shown in Table 4.1, not only was the mean RT of lexical processing much smaller in value than that of the two morphological processing tasks (i.e., separability and combinability), but the variance in the RTs for the lexical processing task was also much smaller. In other words, compared to the morphological processing efficiency tasks, the participants' speed for recognizing the words in the lexical decision task tended to be much more similar (after all, all the items were highly frequent words in English), which eventually did not result in any noticeable difference in reading comprehension between those who responded (slightly) faster or slower.

Another reason might be the psycholinguistic processes that could be differentially involved in the lexical decision task and the morphological processing tasks. Specifically, when learners made a decision on a highly frequent word such as *sweet* and *visit* (in a decontextualized task like the lexical decision task in this study), they might rely only on orthographic processing with little meaning activation, which would be very different from the processing of those words in an actual text reading situation where access to meanings is essential. In contrast, for the two morphological processing tasks, though also decontextualized, rapid semantic activation or attention to stem and affix meanings (e.g., *inform* and *-ation* for the stimulus word *information*) seemed unavoidable. Consequently, the required meaning activation process that seemed to favor the morphological processing tasks might have resulted in the relatively larger effect of morphological processing

efficiency in this study. Such an account may explain the result of Fukkink et al. (2005) as well in that the improvement in the speed for recognizing decontextualized words as a result of the word recognition training might only represent enhanced orthographic (and phonological) processing and not capture the lexical access that is required of reading comprehension.

4.6 Limitations and Future Research

A few limitations of this study are noted. Firstly, it only focused on four major types of lexical competence to explore the lexical basis of reading comprehension. Although it considered both lexical and morphological levels and both knowledge and processing efficiency dimensions, and these predictors explained over 40% of the variance in L2 reading comprehension, efficient reading comprehension does not depend solely on these dimensions. There are arguably other lexical knowledge and skills that underpin (L2) reading comprehension. In the L2 literature, there is, for example, an interest in the role of word or semantic association knowledge, which was often studied as a type of vocabulary depth knowledge (Qian, 1999; Zhang, 2012; see Zhang & Koda, 2017 for a review). Cremer and Schoonen (2013) also distinguished between the availability and accessibility of semantic associating knowledge, which was more or less equivalent to the knowledge vs. processing efficiency distinction it was made in this study. In both L1 and L2 reading literature, there is recently also some attention to the knowledge of connectives (e.g., Crosson & Lesaux, 2013) and knowledge of the formulaic language or multi-word lexical units (e.g., Kremmel, Brunfaut & Alderson, 2017; Martinez & Murphy, 2011). Collectively, these studies and this study help develop a more comprehensive understanding of the lexical basis of (L2) reading comprehension. It would perhaps be, however, too ambitious to accommodate all these dimensions into a single study.

The relative contributions of different dimensions of lexical competence to reading comprehension may depend on learners' L2 proficiency. Some researchers split their sample of readers into "proficient" and "less proficient" subgroups and aimed to examine if any relational patterns would differ between the subgroups (e.g., Cremer & Schoonen, 2013; Shiotsu, 2010; Shiotsu & Weir, 2007). The present study did not perform the *ad hoc* grouping because the participants were literally from the same

learner population. Nonetheless, future research might consider recruiting and comparing learners with distinct levels of language proficiency or at distinct developmental stages.

Finally, a few recent studies have paid attention to how different lexical processes, or linguistic processes in general, may predict L2 reading comprehension differentially depending on the types of comprehension involved, such as literal vs. inferential comprehension (e.g., Li & Kirby, 2015; Zhang & Yang, 2016). In the present study, although the two types of comprehension are distinguished in the Gates-MacGinitie Reading Tests, it did not attempt to compare how the four lexical competences may predict literal and inferential comprehension differentially. This was because there did not seem to be a strong and theoretically interesting reason for us to do so. For example, why might lexical and morphological knowledge contribute differentially to literal and inferential comprehension? Nonetheless, for the research on linguistic processes of L2 reading comprehension in general, it is warranted to pay attention to different types of comprehension, and different types of texts and reading purposes (see Chapter 5).

4.7 Conclusions

In light of the Lexical Quality Hypothesis, this study explored the lexical basis of L2 reading comprehension in a group of adult Arabic-speaking EFL readers by studying the collective and relative contributions of four distinct lexical competences: lexical vs. sub-lexical and knowledge vs. processing efficiency. Hierarchical regression analyses revealed that the four lexical predictors collectively explained over 40% of the variance in the participants' reading comprehension. Compared to the processing efficiency predictors, the knowledge predictors had a predominant influence on reading comprehension. When the knowledge predictors were not considered, sub-lexical/morphological processing efficiency, as opposed to lexical processing efficiency, significantly predicted reading comprehension, over and above working memory. Overall, among the four lexical competences, lexical knowledge was the strongest predictor, followed by morphological knowledge and the processing efficiency predictors.

This study confirmed strong lexical involvement in L2 reading comprehension. It underscored the critical importance of knowledge of word meanings that had been found in many previous studies. Yet, it also showed that knowledge of sub-lexical morphological features is important, too. Although the lexical processing efficiency measures did not significantly predict reading comprehension when lexical and sub-lexical knowledge were concurrently in the model, there was emerging evidence of the importance of the type of processing when meaning recognition is activated. To our knowledge, the present study is the first of its kind that concurrently considered both lexical and morphological knowledge and processing efficiency to study reading comprehension in L2 learners. The findings enrich the current understanding of the fundamental role of lexical processes in L2 reading comprehension. They particularly shed light on how morphological knowledge as well as processing skills may have a unique role to play in adult L2 learners of English.

Chapter 5. Components of Word-to-Text Integration Process in L2 Reading Comprehension[3]

This chapter outlines study 2 of this research that focused on the word-to-text integration process, the second lower-level process of reading comprehension coming after the word recognition process. It examined two components of the word-to-text integration process, that is, syntactic parsing and semantic association by assessing how syntactic and semantic network knowledge differentially predict two types of text comprehension: literal versus inferential in adult second language readers. In this chapter, the related literature is comprehensively scrutinized to address some research gaps. It also includes a detailed description of the methods which were employed to collect data for this study. It is followed by a section that reports the key results of this study. It also provides a critical discussion of these results, and finally, it concludes with some conclusions and limitations which could be directions for further research.

5.1 Literature Review

Reading comprehension entails some "cognitive processes that operate on many different kinds of knowledge to achieve many different kinds of reading tasks" (Perfetti & Adlof, 2012, p. 3). These processes involve lower-order processes that include notably individual word recognition and word meanings access which was the focus of study 1 in this research (see Chapter 4). This initial basis is fundamental to yet insufficient for comprehension because words need to be integrated into the text (Fender, 2001; Grabe, 2009; Perfetti & Stafura, 2014, 2015). Word integration or word-to-text integration is an ongoing process where meanings of individual words are continuously combined into larger units of meaning at the phrase, clause, and sentence levels, and beyond (Fender, 2001; Perfetti & Stafura, 2014).

Word integration process works on two key operations, that is, syntactic parsing and semantic association to comprehend a text. These operations draw upon the reader's syntactic and semantic representations which rely on working memory (Hagoort, 2013; Perfetti & Stafura, 2014). Different word-to-text integration

[3] A version of this chapter was submitted to *TESOL Quarterly* for consideration of publication. At the time of preparing this thesis for submission, the paper is under review with the journal.

operations may have differential effects on text comprehension, depending on the type of comprehension in question. Thus, the following critical review of the literature focused on these two key operations of the word-to-text integration process, and how they may differentially predict literal and inferential comprehension, focusing on L2 adult readers.

5.1.1 Text Comprehension: from Word Recognition to Word-to-Text Integration

Kintsch (1988) in his seminal Construction-Integration Model contends that text comprehension could be explained by an interactive combination of top-down (i.e., knowledge-driven) and bottom-up (i.e., word-based) processes. More specifically, the process of text comprehension starts with the reader accessing and integrating word meanings for establishing a text model, and then the reader building a situation model through activation of background knowledge and various inference processes. To understand a text, reader draws upon a set of lower-level linguistic knowledge and skills to process letters/phonemes, words, clauses, sentences, and pragmatic and discourse structure information; in the meantime, they rely on the knowledge about the world to generate higher-order inferences for integrating the text model and to form a situation model (Grabe, 2009; Perfetti et al., 2005; see, however, Perfetti & Stafura, 2014, 2015).

One of the lower-level processes is word recognition (Nassaji, 2014; Perfetti, 1985). Although the definition of word recognition can differ slightly in its specific context of use, in written text comprehension it often refers to processing the orthographic and phonological form of a word and accessing its meaning. Comprehension of a text is impossible without the learners recognizing the words that make up the text and knowing the meaning of those words (Just & Carpenter, 1980; Perfetti & Adlof, 2012). Word recognition and vocabulary knowledge/size (i.e., knowledge of the [partial] meaning of words) are important predictors of reading comprehension (Grabe, 2009; Melby-Lervåg & Lervåg, 2014; Nassaji, 2014). Vocabulary size, in particular, is a strong correlate of L2 reading comprehension as reported in recent research syntheses or meta-analyses (Choi & Zhang, 2018; Jeon & Yamashita,

2014; Zhang & Zhang, 2020) which was thoroughly reviewed in study 1 (see Chapter 4).

Important as word recognition and knowledge of word meanings are, in the absence of word-to-text integration, they will not lead to text comprehension. In other words, recognizing words in a text and accessing their meanings are necessary but far from sufficient for understanding that text (Oakhill, Cain & McCarthy, 2015). In both L1 and L2 reading, word-to-text integration is important (Fender, 2001; Grabe, 2009; Perfetti & Adlof, 2012; Perfetti & Stafura, 2014, 2015).

5.1.2 Word-to-Text Integration Operations: Syntactic Parsing and Semantic Association

The mechanism and underlying operations are not always clear in that the word-to-text integration process involves a range of mental processes for combining words into larger unit representations phrase, clause, sentence, and beyond. The literature has underscored syntactic (Fender, 2001; Grabe, 2009; Raudszus, et al., 2018) and semantic processing (Perfetti et al., 2005; Perfetti & Stafura, 2014) as two major processes of word-to-text integration, which interplay in comprehension (Hagoort, 2013). These two key operations of word-to-text integration are underscored, that is, syntactic parsing and semantic association work simultaneously and must be executed efficiently for combining words into larger units of representation. Word integration process thus draws upon the reader's syntactic and semantic representations stored in the long-term memory but also relies on working memory (Hagoort, 2013; Perfetti & Stafura, 2014).

Accordingly, readers need to possess both syntactic and semantic knowledge, over and beyond the knowledge that supports word recognition (i.e., vocabulary size), for word-to-text integration and text comprehension. Yet, theoretical accounts on how the two types of integration or how their knowledge underpinnings contribute to text comprehension do not always converge, particularly with respect to semantic integration and "intermediate-level" inference generation (Oakhill et al., 2015; Perfetti & Stafura, 2014, 2015), which is discussed in detail later in this chapter.

Syntactic Parsing and Syntactic Knowledge. As words are recognized, they need to be combined into phrasal and clausal units of meaning based on structural information, a process often known as syntactic parsing (Fender, 2001; Grabe, 2005). The importance of syntactic processing in comprehension can be easily seen from a situation where grammatically important information such as word order is missing. Compare, for example, "*Broke antique washing night the all the be man will vase dishes who*" with "*The man who broke the antique vase will be washing dishes all night*" (Grabe, 2009, p. 29). Other than word order, a number of other types of syntactic information can affect word-to-text integration and text comprehension, including, for example, argument structure of verbs, tense, aspect, subject-verb agreement, case markings, and articles. These types of information constitute "a network of cueing systems" in text comprehension that provide "a continuous lower-level stream of information that anchors comprehension processing" (Grabe, 2009, p. 203). Syntactic integration serves as a stepping-stone between word recognition and text comprehension. To combine words into larger units of meaning or construct semantic propositions using the cueing systems (Fender, 2001), the reader needs to possess various aspects of syntactic knowledge, in addition to the knowledge that supports word recognition and knowledge of word meanings (Grabe, 2005; Jeon & Yamashita, 2014).

In L2 reading research, there has long been an interest in syntactic involvement in reading comprehension (Grabe, 2005; Urquhart & Weir, 1998). Syntax was found to affect text readability (Crossley, Greenfield & McNamara, 2008); and syntactic modification improved text comprehension (Oh, 2001). Syntactic knowledge also distinguishes skilled L2 readers from less-skilled ones (Nassaji, 2003). Nassaji's study (2003) was conducted with adult English as a second language measuring their reading comprehension, syntactic, semantic, word recognition, phonological, and orthographic processing skills. One-way discriminant function analysis revealed that lower-level component processes, such as word recognition and graphophonic processes, in addition to higher-level syntactic and semantic processes, contributed significantly to the distinction between skilled and less-skilled L2 readers.

Some other studies on both young and adult L2 learners of English also found that syntactic knowledge predicted reading comprehension (Raudszus et al., 2018; Shiotsu & Weir, 2007). Shiotsu and Weir (2007), for example, found syntactic knowledge significantly predicted reading comprehension, over and beyond vocabulary knowledge, in university learners of English in Japan. Likewise, Raudszus et al. (2018) found syntactic integration significantly predicted reading comprehension, controlling for vocabulary knowledge and decoding. In their study, syntactic integration of young monolingual and bilingual who were learning to read in Dutch was assessed by the grammaticality judgment task.

In fact, recent meta-analyses or research syntheses showed that grammatical knowledge is one of the strongest correlates of L2 reading comprehension (Choi & Zhang, 2018; Jeon & Yamashita, 2014). Choi and Zhang (2014) found that grammatical knowledge outperformed vocabulary knowledge in explaining L2 reading comprehension in eight studies. In Jeon and Yamashita's meta-analysis (2014) the correlation between grammatical knowledge and reading comprehension was strong (r= .85), and statistically significant (p = .00) in sixteen studies.

What remains to be explored, though, is how syntactic integration and other processes of integration such as semantic integration which is discussed in the next section or their respective knowledge underpinnings may differentially contribute to reading comprehension. Given that syntactic integration is primarily concerned with constructing phrasal, clausal, and sentential meaning or local cohesion and coherence (Fender, 2001), syntactic knowledge may be primarily important for generating understanding of the literal meaning or what is explicit in a text (i.e., literal comprehension), as opposed to inferential comprehension, which is a deeper level of comprehension where the reader needs to rely on additional processes, such as semantic association discussed below, to read "between the lines." This issue has rarely been tested in the L2 literature where there was a heavy reliance on more global measures of comprehension for assessing the contribution of different processes (see Choi & Zhang, 2018).

Semantic Association and Semantic Network Knowledge. Syntactic processing for combining words to construct semantic propositions is not the sole process of

word-to-text integration, which also involves semantic processing where comprehenders draw upon their knowledge of semantic relations between words in the mental lexicon to integrate word meanings and fill any semantic gaps for coherence building (Oakhill, 2020; Perfetti & Stafura, 2014, 2015). In native speakers as well as L2 learners, whenever words are picked up and enter the mental lexicon, they are integrated into a lexical network where associative links are established with existing words in the network through various types of semantic relations (Aitchison, 2012; Meara, 2009; Read, 2004). These words associations or semantic network serves as an important basis for language comprehension.

In explaining how coherence is built and maintained in text comprehension, the Reading Systems Framework highlights that inference generation is not solely a top-down knowledge-driven process (e.g., background knowledge; cf. Anderson & Pearson, 1984) but involves at least some lexically-driven processes initiated by lower-level recognition of words and integration of words (Oakhill et al., 2015; Perfetti & Stafura, 2014). Perfetti and Stafura (2015) distinguished between “the linguistically constrained implicit meaning” and “the linguistically independent, reader-constructed implicit meaning” to underscore the distinction between the two processes. As words are recognized and their meanings activated (i.e., the word identification system), they need to be integrated into the ongoing context such as a sentence or a larger discourse unit across sentences (i.e., the comprehension system). This process is characterized by selecting context-specific word meanings and integrating incoming words into the current situation model and updating the model. This semantic or lexical association process has been observed in a number of ERP studies conducted by Perfetti and colleagues where semantically related words are continuingly fed into the comprehension system (e.g., Perfetti, et al., 2008; Yang, et al., 2007).

Perfetti and colleagues (e.g., Perfetti, 2007; Perfetti et al., 2008) have demonstrated that the availability of associative links between words and concepts—the consequence of a rich (deep) vocabulary—might aid comprehension by supporting inference making in adults. In further details, Perfetti et al. (2008) examine comprehension skill differences in the processes of word-to-text integration, the

connection of the meaning of a word, as it is read, to a representation of the text of adult readers by reviewing two studies (one of them is the study of Yang et al., 2007). They concluded that for skilled comprehenders, integration processes were reflected in N400 indicators when a critical word had an explicit link to a word in the prior text and by both N400 and P300 indicators when its meaning was a paraphrase of a prior word. When forward inferences were required for subsequent word-to-text integration, effects for skilled comprehenders were not reliable. Less skilled comprehenders showed delayed and less robust ERP effects, especially when meaning paraphrase was the basis of the integration.

In the example discussed in Perfetti and Stafura (2014), when the sentence "*While Cathy was riding her bike in the park, dark clouds began to gather, and it started to storm*" is being read, the situation model (i.e., IN THE PARK, CATHY ON BIKE, and DARK CLOUDS) is updated with the STORM event integrated. ERP evidence (N400) on the word "rain" in the follow-up sentence "*The rain ruined her beautiful sweater*" showed that this sentence or proposition is easily integrated into the existing situation model and update it because it fits the context very well. This semantic integration or "paraphrase effect" may be understood to serve some function of bridging inference but is a distinct process (Perfetti & Statufa, 2014); it was later interpreted in Perfetti and Stafura (2015), on an *ad hoc* basis, as an "intermediate-level inference."

The execution of the aforementioned semantic process necessarily draws upon the reader's knowledge about semantic relationships between words or their semantic network knowledge and knowledge of the context-specific meaning of individual words is of course also important. To construct coherence between "*A few bombs fell on the town*" and "*Luckily, little damage was caused to property*" through the integration of the word "damage" to the previous context or situation model on bombing, the "damaging" sense associated with bombing will need to be retrieved and held in working memory, which means the reader needs to know the associative link between *bomb* and *damage*. Semantic association or network knowledge of this kind is hence crucial for inference generation and construction and maintenance of local as well as global coherence as text reading unfolds. As Oakhill (2020) pointed

out, “rich and well-connected semantic representations of words will permit the rapid activation not only of a word’s meaning but also the meanings of related concepts;” and “many of the local cohesion and global coherence inferences in the text depend on semantic links between words in the text” (pp. 413-414).

The contribution of semantic network knowledge to comprehension is sometimes studied under the name of vocabulary depth (Cain & Oakhill, 2014; Ouellette, 2006; Oakhill et al., 2015), which is distinct from vocabulary breadth or size or the number of words with a (partial) meaning known (Anderson & Freebody, 1981; Read, 2004; Schmitt, 2014; Zhang & Koda, 2017). The semantic association is also conceptualized as an important underlying component of lexical quality (e.g., Oakhill, 2020; Richter, Isberner, Naumann & Neeb, 2013).

The Lexical Quality Hypothesis (Perfetti & Hart, 2002; Perfetti, 2007) contends that high-quality representations of lexical and sub-lexical features are fundamental for comprehension as discussed in study 1 (see Chapter 4). While lower-level knowledge and skills that support word recognition (e.g., phonological and orthographic processing) and vocabulary size are arguably important for comprehension, the “semantic constituent of lexical quality” or vocabulary depth should also play a crucial role to reading comprehension (Perfetti & Stafura, 2014, 2015; Oakhill, 2020; Oakhill et al., 2015).

Empirically, a small but increasing body of research has focused on semantic network knowledge (or however else it is called such as vocabulary depth) as a predictor of reading comprehension over and beyond word recognition skills in monolingual (e.g., Cain & Oakhill, 2014; Cain et al., 2004; Ouellette, 2006; Roth et al., 2002; Tannenbaum et al., 2006) as well as bilingual readers (e.g., Cremer & Schoonen, 2013; Spätgens & Schoonen, 2018).

In Ouellette’s study (2006) semantic network knowledge is measured using word definitions and synonyms. In the word definitions subtest, a word was presented to the student in both written and spoken form, and the student was asked to provide a definition for the word. On the other hand, in the synonyms subtest, the student was required to select one of four words that are the synonym of a presented target

word. All words were presented also in written and spoken form. Distractor items included antonyms, associated words, and members of the same semantic class. They concluded that semantic knowledge was influential to comprehension processes.

Cain and Oakhill (2014) included two measures to assess vocabulary depth knowledge (i.e., semantic network knowledge in the current study) from the Wechsler Intelligence Test for Children – III (WISC-III: UK edition, Wechsler 1992), and the Vocabulary and Similarities subtests. The Vocabulary subtest of the WISC-III requires participants to define words that increase in difficulty, for example, “alphabet,” “island,” “precise,” and the Similarities subtest requires participants to identify how two things are similar, for example, “wheel” and “ball” (easy item) and “first – last” (more difficult item). These two measures were applied to tap the richness of knowledge about the words that are known. The findings of their study revealed that the depth of vocabulary knowledge is an important predictor of both reading comprehension and comprehension-related skills.

Additionally, Oakhill et al. (2015), in their first study, included the same two assessments of vocabulary depth knowledge that were applied in Cain and Oakhill’s study, (2014): the Vocabulary and Similarities subtests. They concluded that the depth of vocabulary knowledge is the more critical factor in accounting for performance on global coherence inferences (even after literal memory for the text is taken into account).

The semantic association is also conceptualized as an important underlying component of lexical quality (e.g., Oakhill, 2020; Richter et al., 2013). Specifically, Richter et al. (2013), focused on 247 primary school students between 6 and 10 years of age, and the lexical quality was involved the quality of meaning representations that were measured with a categorization task that included a spoken categorical word (e.g., animal) and a written word (e.g., dog) presented after a short delay of 200 ms. This task essentially requires access to word meanings.

Later, Oakhill (2020) suggests that “*depth of vocabulary knowledge is likely to be more important than breadth in supporting inference and integration in particular*

because rich and well-connected semantic representations of words will permit the rapid activation not only of a word's meaning but also the meanings of related concepts. It is plausible that in children a rich (deep) vocabulary knowledge will support inference making in comprehension because many of the local cohesion and global coherence inferences in the text depend on semantic links between words in the text. This activation of a semantic network can then provide the basis for many of the inferences that are crucial for the construction of a coherent representation of a text: a sort of "scaffold" for the mental model" (p. 413-414).

Research to date has already established that knowledge of semantic network knowledge (i.e., depth, semantic associates, or semantic relations) contributes and it is a significant predictor of reading comprehension (Cain & Oakhill, 2012; Ouellette, 2006; Roth et al., 2002; Schoonen & Verhallen, 2008; Tannenbaum et al., 2006). For example, Ouellette (2006) found that the ability to produce synonyms, unique semantic features and category superordinates contributed to reading comprehension in monolingual children, even more so than vocabulary size. Cremer and Schoonen (2013) applied the Word Associates Test (Schoonen & Verhallen, 2008), which required their 10- to 11-year-old monolingual and bilingual participants to distinguish subordinates, superordinates, synonyms, meronyms, and defining characteristics from contextually related distractor items. The children who were better at selecting the context-independently related items also obtained higher reading scores, suggesting that these items may be particularly important for reading comprehension.

Empirically, some prior studies show that integrating information between sentences to establish local coherence, it is crucial to understand and make use of synonyms (Currie & Cain, 2015). For example, children who differ in reading comprehension skills differ in their understanding and use of synonyms to integrate different propositions in a text (Cain & Nash, 2011). Additionally, it was proposed that poorer use of these signalling cues may have limited local coherence inference making for the children in a study conducted by (Currie & Cain, 2015). This signifies semantic network knowledge as a component of the word-to-text integration process for local coherence or inferencing (i.e., semantic association in this study) and finally for

successful text comprehension (Currie & Cain, 2015). In the L2 literature, there has been an interest in how vocabulary size is important yet insufficient in explaining individual differences in reading comprehension and how vocabulary size and depth relatively predict reading comprehension (e.g., Qian, 1999; Zhang, 2012).

Words are paradigmatically associated when they form semantic relations such as synonyms, or antonyms, and belong to the same word class. In other words, paradigmatic refers to an associate from the same word class and performs the same grammatical function as the target word in a sentence (e.g., a synonym) (Zhang & Yang, 2016). Syntagmatic association, on the other hand, pertains to an associate with a sequential relationship to the target word in a sentence and is usually a word from a different word class namely collocation. Specifically, mastery of collocations seems to be robustly related to general language proficiency (Schmitt, 2014). Drawing on this paradigmatic-syntagmatic categorization, (Read, 1993, 1998) developed the Word Associates Test (WAT) to measure English L2 learners' vocabulary depth. Thus, in this study, semantic network knowledge for the semantic association process involves both paradigmatic associations (i.e., synonyms, antonyms, and hyponymy) knowledge and syntagmatic association (i.e., collocations) knowledge. Read's (1998) WAT, which incorporates syntagmatic and paradigmatic associative relations between words, has been a popular tool for measuring L2 learners' vocabulary depth and studying its contribution to English reading comprehension (see Zhang & Koda, 2017).

In some studies, although the relative strength of vocabulary size versus depth did not always converge (e.g., Qian, 1999, 2002; Zhang, 2012), semantic network knowledge measured with the WAT or measures of a similar form usually significantly predicted reading comprehension (e.g., Cremer & Schoonen, 2013; Zhang, 2012; Zhang & Yang, 2016). Zhang (2012) examined the contribution of vocabulary knowledge to second language reading comprehension among 190 advanced Chinese English as foreign language learners. Vocabulary knowledge was measured in both breadth (Vocabulary Levels Test) and depth (Word Associates Test); reading comprehension had three indicators, namely, coreference,

textual inference, and gist. Vocabulary knowledge related significantly to reading comprehension.

Zhang and Yang (2016) used a Chinese Word Associates Test (WAT-C) to examine the vocabulary depth of second language learners of Chinese and its contribution to the learners' reading comprehension. The results showed vocabulary depth was found to be a significant and unique predictor of reading comprehension over and above vocabulary size. On the other hand, the relative contributions of vocabulary depth and size depended on what types of texts were read and what comprehension skills were assessed.

5.1.3 Word-to-Text Integration Process and Working Memory

Like other lower-level processes, word-to-text integration needs to be executed efficiently for mental model construction. The Memory, Unification, and Control Framework emphasizes the role of control processes, such as working memory and inhibition, for the integration process to be achieved (Hagoort, 2013). Specifically, these control processes are necessary to guide the unification of elements retrieved from the long-term memory into larger units with new meaning. As words are recognized incrementally in a sentence, they must be held in working memory for integration to happen. Both syntactic and semantic integration work within the constraints of working memory (Currie & Cain, 2015; Raudszus et al., 2018). In fact, working memory is a limited-capacity system that affects an individual's ability to carry out many processes associated with text comprehension (Cain et al., 2004; Shin, Dronjic & Park, 2019); and it can be particularly important for inferential comprehension (Alptekin & Ercetin, 2011).

5.1.4 Word-to-Text Integration Operations and Types of Textual Comprehension

The components of word-to-text integration (i.e. syntactic parsing and semantic association), based on the corresponding aspects of linguistic knowledge, could contribute differently to various reading tasks that are literal or inferential in nature. As noted earlier, what remains to be understood, however, is how the knowledge underpinnings of different word-to-text integration processes may be differentially important depending on the type of comprehension. The Reading Systems

Framework (Perfetti & Stafura, 2014, 2015; see also Oakhill et al., 2015) underscores that at least some inference is generated through the semantic integration process for which lexical association or semantic network knowledge (or vocabulary depth) is essential. In this respect, semantic integration, while necessary for comprehension in general, may be particularly important for inferential comprehension compared to syntactic integration.

5.2 The Present Study

The above theoretical discussion and review of empirical evidence have confirmed the importance of both syntactic and semantic integration for L2 reading comprehension. The two operations are executed simultaneously and interact in reading comprehension. Yet, to our knowledge, no published studies seemed to have aimed to explore how knowledge underpinnings of these two processes may have differential contributions depending on the type of comprehension in question. The current study aimed to address this gap by assessing how syntactic and semantic network knowledge may differentially predict literal and inferential comprehension, over and beyond working memory and vocabulary knowledge/size in adult L2 readers of English. It aimed to answer the following three questions:

1. Do syntactic knowledge and semantic network knowledge, which respectively underpin the syntactic and semantic process of word-to-text integration, uniquely predict reading comprehension in adult L2 readers of English?
2. How do the two types of knowledge relatively predict literal comprehension?
3. How do the two types of knowledge relatively predict inferential comprehension?

5.3 Method

5.3.1 Participants

Data were collected from 268 Arabic-speaking students in a university in Saudi Arabia. They all were female. Their age ranged between 17 and 22 years old (M = 20 years). Thirty-nine of them were excluded for the analyses reported later, because they missed one or more of the tests described below due to random

absence at testing sessions. They represented a range of undergraduate majors (For more details about the participants see Chapter 3, section 3.3).

5.3.2 Measures

The participants completed a battery of computer and paper-based tests on a group and individual basis (see Figure 5.1). These measures mainly assessed EFL learners' passage comprehension using a reading comprehension test, vocabulary knowledge, working memory capacity, syntactic knowledge, and semantic network knowledge.

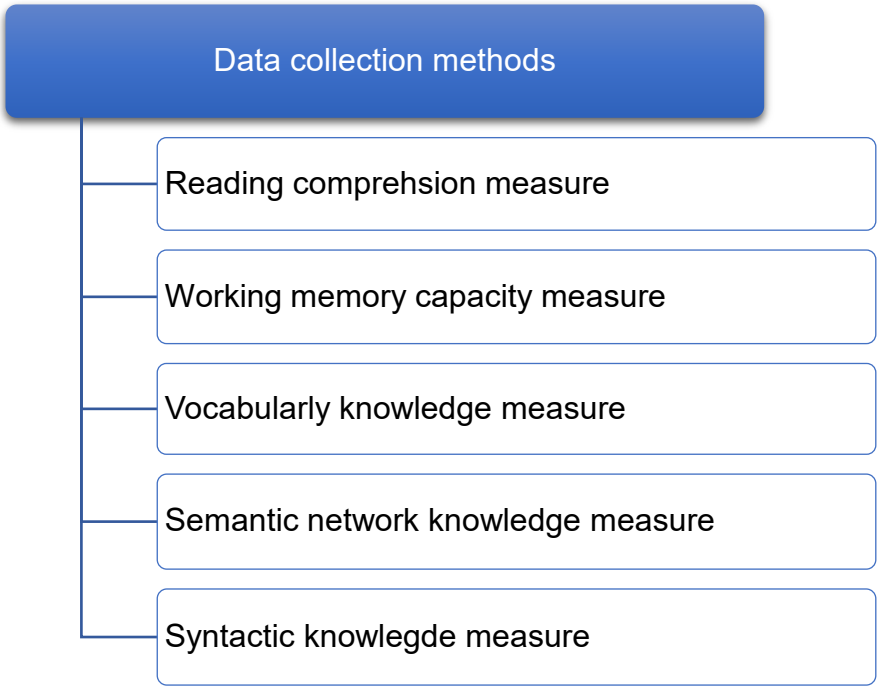

Figure: 5.1 Study 2 data collection methods

Reading Comprehension Measure. Reading comprehension was assessed as a main variable in study 1 and this one (see, 4.3.2). In this study, separate scores were additionally calculated for each literal and inferential comprehension. The total score for overall comprehension as well as the total of each type of comprehension were considered in the analyses as three separate dependent variables.

Vocabulary Knowledge/Size Measure. To model the contribution of syntactic and semantic network knowledge to reading comprehension, it is important to control for readers' knowledge of individual words, as this knowledge is essential for text

comprehension; and vocabulary size is a strong correlate of reading comprehension (Jeon & Yamashita, 2014). Vocabulary knowledge/size was measured with an abridged version of the Vocabulary Levels Test (VLT) (Schmitt et al., 2001). This measure is the same measure that was used in study 1 to assess the lexical level knowledge and it was also described earlier (see 4.3.2). It was included as a covariate when reading comprehension was predicted by different components of word-to-text integration in regression analysis.

Syntactic Knowledge Measure. Syntactic knowledge was measured with a researcher-developed grammatical error correction task. This measure consisted of 15 items or lexically simple sentences where there was a grammatical error in each sentence. Participants were first asked to identify the part of the sentence, from three underlined choices, that made the sentence ungrammatical and then corrected the identified part to make the sentence grammatical. For example, in *This is the man which house is on fire*, *which* is the erroneous part, which can be corrected to *whose* to make the sentence grammatical (see Appendix 11).

This measure covered various aspects of grammar such as subject-verb agreement, verb tenses, irregular verbs, passive, relative clauses, pronouns, prepositions, and word order. Two criteria were applied in selecting the target sentences: first, words needed to be simple to minimize lexical unfamiliarity; and second, the error in each sentence had to be correctable. Following Zhang (2012), participants received one point for correct error identification and an additional point for an appropriate error correction and zero points for incorrect answers and for missing responses. An example was given; and instructions were given in both English and Arabic. The maximum score was 30. It took roughly 20 minutes for all students to complete this test. The Cronbach's α was .875.

Semantic Network Knowledge Measure. Participants' semantic network knowledge was measured with a multiple choices task that tapped various semantic relationships between words. As mentioned earlier in this chapter, Read's (1998) WAT is a well-known task employed in the L2 literature to measure semantic network knowledge or vocabulary depth. Learners are basically asked to identify the paradigmatic (i.e., synonyms, antonyms, and hyponyms) and syntagmatic

associates (i.e., collocates) of an adjective from a list of adjectives and nouns. The original WAT, however, was not used for this study, because many target words and choices were unfamiliar to the participants, which would threaten the validity for measuring knowledge of semantic relationships between (known) words (see discussion in Zhang & Koda, 2017). Consequently, a test was developed, which consisted of two separate sections focusing on the paradigmatic and syntagmatic association, respectively.

The first section consisted of three groups of five items (a total of 15 items), which focused on synonymy, antonymy, and hyponymy, respectively. In each item, a target word (adjective, noun, or verb) was followed by four candidate associates, one of which was a synonym, antonym, or hyponym of the target word. For example, option: *choice, unit, answer, chance*. An example was given for each type of semantic relation. The second section also consisted of 15 items. For each item, participants were asked to select a word that best collocates with the word presented in the prompt. For example, __ line: *high, long, tall, large* (see Appendix 12). Each correct choice received one point; an incorrect or missing response received zero points. An example was also provided for this section. Instructions were given in both English and Arabic. The maximum score possible for the test was 30. The task was completed by the participants in approximately 20 minutes. The Cronbach's α was .898.

Working memory capacity measure. Working memory capacity was measured with the same computerized digital span task that was employed in study 1 (see 4.3.2 for more details). It was also included as a covariate in regression analysis.

5.4 Results

5.4.1 Descriptive Statistics and Bivariate Correlations

The means, standard deviations, reliabilities, and skewness and kurtosis values for all measures are reported in Table 5.1 Overall, the measures were all normally distributed as the skewness and kurtosis estimates were below the rule-of-thumb values (i.e., ±2) for univariate normality. Their reliability was also good or acceptable, except for literal and inferential comprehension. For these two sub-types of correlation, Cronbach's alpha, which was .493 and .398 respectively, appeared low

(the reliability of reading comprehension as a whole seemed acceptable), which was possibly due to the small number of items (10 items for literal comprehension and 11 items for inferential comprehension) (Taber, 2018). The accuracy rate and raw RT are both presented for working memory, but it was the IES RT that was used for subsequent bivariate correlation and regression analyses. Based on the percentage of correct answers, the participants, perhaps unsurprisingly, performed significantly better on literal comprehension than inferential comprehension ($t = 5.240$, $p < .001$).

Table 5.1

Measures and Descriptive Statistics of Study 2

	N	Mean	*SD*	Rel. (α)	Skewness		Kurtosis	
					Statistics	Std. Error	Statistics	Std. Error
Reading comprehension	21	8.17	3.43	.630	.479	.154	-.161	.306
Literal comprehension	10	4.24	1.99	.493	.258	.154	-.334	.306
Inferential comprehension	11	3.92	1.97	.398	.481	.154	-.030	.306
Working memory (accuracy)	20	14.02	3.73	.754	-1.110	.151	1.740	.300
Working memory (raw RT)	-	1988.3	320.7	-	-.079	.152	-.046	.302
Vocabulary knowledge	72	37.87	14.51	.949	.320	.151	-.490	.300
Syntactic Knowledge	30	14.67	6.53	.875	.505	.154	-.664	.306
Semantic network knowledge	30	16.96	7.21	.898	.052	.154	-.1.096	.306

Note. *N* = number of test items; SD = standard deviation; Rel. (α) = Reliability (Cronbach's α).

Table 5.2 shows the bivariate correlations between all the variables. To highlight, reading comprehension correlated significantly with all other variables, including both syntactic knowledge ($r = .476$) and semantic network knowledge ($r = .605$), both ps < .001. Literal and inferential comprehension correlated significantly ($r = .498$, p <. 001); and the correlations of both with other variables were significant as well, except that between working memory and inferential comprehension ($r = -.104$). Syntactic knowledge correlated significantly and positively with both types of

comprehension: *r*s = .422 and .402 for literal and inferential comprehension, respectively (both *p*s < .001). Semantic network knowledge also correlated significantly and positively with literal (*r* = .517) as well as inferential comprehension (*r* = .530), both *p*s < .001. Overall, while semantic network knowledge had slightly stronger correlations with both types of reading comprehension than did syntactic knowledge, the pattern seemed more salient for inferential comprehension.

Table 5.2

Bivariate Correlations Between All Measured Competences of Study 2

		1	2	3	4	5	6	7
1	Reading comprehension	_						
2	Literal comprehension	.867***	_					
3	Inferential comprehension	.864***	.498***	_				
4	Working memory	-.168**	-.186**	-.104	_			
5	Vocabulary knowledge	.626***	.543***	.542***	-.198***	_		
6	Syntactic knowledge	.476***	.422***	.402***	-.225***	.540***	_	
7	Semantic network knowledge	.605***	.517***	.530***	-.267***	.822***	.555***	_

*p < .05, **p < .01, ***p < .001

5.4.2 Contribution of Word-to-Text Integration Components to Reading Comprehension

Three sets of hierarchical regression analyses were performed to examine the unique contribution of word-to-text integration components to reading comprehension and its sub-levels (literal and inferential). In each set of analyses, a baseline model was first created to control for the effects of working memory and vocabulary knowledge. Syntactic knowledge and semantic network knowledge were then added to the model consecutively. To determine any distinct contribution of the

two knowledge components for word-to-text integration, the order of entry for semantic network knowledge and syntactic knowledge was switched.

As shown in Table 5.3, working memory, as the first variable in the model, significantly predicted reading comprehension (p = .011). Controlling for working memory, vocabulary knowledge/size explained a substantial amount of variance in reading comprehension (p < .001). Together, these two control variables accounted for about 38.9% of the variance in reading comprehension. Over and beyond the two control variables, syntactic knowledge significantly predicted reading comprehension (p = .002), adding about 2.5% to the variance explained. As the last variable added to the regression equation, syntactic knowledge contributed an extra 1.5% of the variance in reading comprehension (p < .016). A similar pattern was observed when the order of entry for syntactic and semantic network knowledge was switched. Syntactic knowledge entered as the last step significantly explained an additional 1.7% of the variance in reading comprehension (p = .010) after accounting for the effect of working memory, vocabulary knowledge, and semantic network knowledge (see Table 5.3). Altogether the four predictors explained over 42% of the variance in reading comprehension. Overall, it can be concluded that both word-to-text integration components were a significant, unique predictor of reading comprehension, although the effect size for both appeared small after the effects of vocabulary knowledge and working memory were concurrently considered.

Table 5.3

The unique contribution of e*ach word-to-text integration component to reading comprehension*

Steps	Predictors	R^2	*Adjusted* R^2	ΔR^2	*P*
1	working memory	.028	.024	.028	.011
2	Vocabulary knowledge	.394	.389	.366	.000
3	Semantic network knowledge	.418	.410	.023	.003
4	Syntactic knowledge	.435	.424	.017	.010

3	Syntactic knowledge	.420	.412	.025	.002
4	Semantic network knowledge	.435	.424	.015	.016

5.4.3 Contribution of Word Integration Components to Literal vs. Inferential Comprehension

Two separate sets of hierarchical regression analyses with literal and inferential comprehension as the respective criterion variable were further conducted to assess how the two components of word-to-text integration may differentially contribute to reading comprehension depending on the type of comprehension in question. As shown in Table 5.4, the effect of both working memory and vocabulary knowledge was significant. These two covariates in total explained about 29.5% of the variance in literal comprehension. Over and beyond these covariates and syntactic knowledge, a significant, unique effect of semantic network knowledge did not surface (p = .130). It only explained about 0.7% of the variance in literal comprehension. On the other hand, controlling for all the other three variables, syntactic knowledge explained a small but significant amount of variance (about 1.5%) in literal comprehension (p = .026).

Table 5.4

The unique contribution of each word-to-text integration component to literal comprehension

Steps	Predictors	R^2	*Adjusted* R^2	ΔR^2	*P*
1	Working memory	.034	.030	.034	.005
2	Vocabulary knowledge	.301	.295	.267	.000
3	Semantic network knowledge	.314	.304	.012	.044
4	Syntactic knowledge	.329	.317	.015	.026
3	Syntactic knowledge	.322	.313	.021	.009
4	Semantic network knowledge	.329	.317	.007	.130

Table 5.5 shows the result of the regression analysis for inferential comprehension. Working memory was not a significant predictor of inferential comprehension. The effect of vocabulary knowledge, however, was also significant; it explained about 28.3% of the variance in inferential comprehension. Unlike when literal comprehension was the criterion variable, semantic network knowledge explained a small but significant additional amount of variance (about 1.6%) in inferential comprehension (p = .021), over and above the two covariates and syntactic knowledge; and when syntactic knowledge was the last predictor entered into the regression model, a significant, unique effect did not surface (p = .065); and the proportion of additional variance explained was very little.

Table 5.5

The unique contribution of each word-to-text integration component to inferential comprehension

Steps	Predictors	R^2	*Adjusted* R^2	ΔR^2	*P*
1	Working memory	.011	.007	.011	.116
2	Vocabulary knowledge	.293	.287	.283	.000
3	Semantic network knowledge	.317	.308	.023	.006
4	Syntactic knowledge	.327	.315	.010	.065
3	Syntactic knowledge	.311	.302	.017	.018
4	Semantic network knowledge	.327	.315	.016	.021

5.5 Discussion

The present study distinguished between two major types of word-to-text integration, that is, syntactic parsing and semantic association; and set out to examine how the knowledge underpinning of these integration processes may differentially predict different types of comprehension. While both syntactic and semantic network knowledge was a unique, significant predictor of reading comprehension, disregarding the type of comprehension, contrasting patterns were found for literal and inferential comprehension.

5.5.1 Contribution of Word-to-Text Integration Components to Reading Comprehension

To answer the first research question, disregarding the type of comprehension, that is, based on the global measure of comprehension, both syntactic and semantic network knowledge were significant, unique predictors of reading comprehension. Their unique effect was assessed with the control of vocabulary knowledge/size and working memory, particularly the former, which has been found to be a strong correlate of L2 reading comprehension (Jeon & Yamashita, 2014; Zhang & Zhang, 2020) and also explained a substantial amount of variance in reading comprehension in this study. Both syntactic and semantic network knowledge explained a small but significant amount of unique variance in reading comprehension. This finding was not a surprise, given that the two types of knowledge underpinned distinct word-to-text integration processes, both of which are theoretically essential, and thus need to be simultaneously in place, for constructing the meaning of larger units (clausal, sentential, and beyond), over and beyond word recognition and access to word meanings (Fender, 2001; Grabe, 2009; Nassaji, 2014; Perfetti & Stafura, 2014).

This finding also corroborates previous studies that showed the importance of syntactic knowledge (e.g., Proctor et al., 2012; Raudszus et al., 2018; Shiotsu & Weir, 2007) as well as vocabulary depth knowledge (Qian, 2002; Qian & Schedl, 2004; Zhang & Yang, 2016) in L2 reading comprehension. Additionally and more importantly, it extends the literature where there was a particular interest in comparing the contribution of lexical/vocabulary (size) vs. grammatical knowledge on the one hand (e.g., Shiotsu & Weir, 2007; Zhang, 2012; see Choi & Zhang, 2018 for a review), and that of vocabulary size vs depth on the other in L2 reading comprehension (e.g., Qian, 1999, 2002; Zhang, 2012; see also Zhang & Zhang, 2020). The present study contributed to that body of the literature through a distinct perspective. A distinguishment between word recognition and word-to-text integration processes in text comprehension was made. It was acknowledged that word recognition and knowledge of individual word meanings (i.e., vocabulary size) are fundamental to propositional meaning construction and text model construction, yet also pointed it out the insufficiency of these lower-order processes in text

comprehension (Grabe, 2009; Kinstch, 1998; Oakhill, 2020; Perfetti et al., 2005). The comparison between syntactic and semantic word-to-text integration or syntactic vs. semantic network knowledge has provided a new perspective on studying the contribution of linguistic processes to larger units meaning construction and L2 reading comprehension beyond the basic process that concerns individual words (see also Nassaji, 2003).

5.5.2 Differential Contributions to Literal vs. Inferential Comprehension

In addition to the aforementioned distinct perspective, the present study has addressed another notable niche, that is, a distinguishment between literal and inferential comprehension was made and explored how knowledge underpinnings of syntactic and semantic word-to-text integration may differentially contribute to reading comprehension depending on the type of comprehension in question. To answer the second and third research questions, controlling for working memory and vocabulary knowledge, syntactic knowledge, as opposed to semantic network knowledge, significantly predicted literal comprehension, whereas, for inferential comprehension, a converse pattern was found.

As noted in the review of literature, previous studies relied heavily on global measures of L2 reading comprehension (see Alptekin & Erçetin, 2011; Li & Kirby, 2014; Zhang & Yang, 2016 for a few notable exceptions), which has restricted understandings about the complexity of component processes that interplay in text comprehension. The unique contribution of syntactic knowledge for literal comprehension, which concerns the understanding of messages explicitly presented in a text, seems quite reasonable because structural information is essential for word integration (Grabe, 2009). The fact that semantic network knowledge did not surface as a significant predictor of literal comprehension, after controlling for vocabulary knowledge/size and syntactic knowledge, seems to match exactly recent new perspectives on how semantic association functions in text comprehension (e.g., Oakhill, 2020; Perfetti & Stafura, 2014, 2015). That is, the process of integrating words into ongoing context plays an important role in inference generation and continuous construction of coherence as text reading unfolds.

This is exactly what the finding of the present study showed for inferential comprehension, that is, semantic network knowledge, as opposed to syntactic knowledge, uniquely and significantly predicted inferential comprehension. Models of text comprehension generally underscore high-order inference as a knowledge-driven process. For example, in the Construction-Integration Model (Kintsch, 1998), word-level processes are for text model construction, and world knowledge is integrated to generate inferences and construct the situation model. Based on consistent neurocognitive evidence, Perfetti and colleagues (e.g., Perfetti & Stafura, 2014, 2015) proposed that there is at least some lexically-driven process (i.e., words being continuously integrated into ongoing context and modifying, updating, or "fine-tuning" the situation model for construction and maintenance of coherence) that possibly interacts with the knowledge-driven process for inference generation and situation model building. In this respect, the unique contribution of the "semantic constituent of lexical quality" (Perfetti & Stafura, 2014, 2015), which was measured in the form of semantic network knowledge in the present study, to inferential comprehension was not unexpected.

One may argue that, as semantic network knowledge measures vocabulary depth and some studies in the L2 literature have shown the importance of vocabulary depth to reading comprehension (e.g. Qian, 1999; Zhang & Yang, 2016), the findings reported in this study may not be particularly interesting, despite the new perspective through the lens of word-to-text integration. However, it would be emphasized that it is exactly that the lens of word-to-text integration and the focus on inferential comprehension that made the present study important and the findings interesting. Although a small but increasing number of studies have confirmed the importance of vocabulary depth (or semantic network knowledge such as measured with the WAT; Read, 1998) in L2 reading comprehension (see Zhang & Koda, 2017), what remains puzzling is *how* this depth knowledge is uniquely important, over and beyond vocabulary size (such as what the VLT intended to measure in the present study). Often times, a study that aimed to compare vocabulary size vs. depth in reading comprehension was framed primarily through differentiating the different dimensions of vocabulary knowledge (e.g., Zhang, 2012; Zhang & Yang, 2016) rather than aiming to first and foremost theoretically delineating how (distinct) lexical

processes drive text comprehension. In this respect, Perfetti and colleagues' Reading Systems Framework (Perfetti & Stafura, 2014) as well as their emphasis on lexical quality and comprehension (Perfetti, 2007), although contextualized in L1 reading, have much to inform understanding about L2 reading comprehension, particularly semantic association/vocabulary depth and inferential comprehension. These important theoretical insights have underpinned some recent empirical work on L1 reading (e.g., Cain & Oakhill, 2014; Richter et al., 2013; Segers & Verhoeven, 2016); yet their influence in L2 reading comprehension research is only beginning to be visible (e.g., Proctor et al., 2012; Raudszus et al., 2018). The present study thus extends the current body of research in light of its focus on word-to-text integration and different types of comprehension, particularly the significance of semantic integration and inference generation for explaining any empirical relationship between vocabulary depth and reading comprehension.

5.6 Limitations and Future Research

This study was a preliminary effort to explore word-to-text integration processes and their differential contribution of these distinct processes to literal and inferential comprehension in L2 readers, hence not without limitations. To begin with, the reliability of literal and inferential comprehension tests was low, possibly due to the small number of questions (10 for literal comprehension and 11 for inferential comprehension). Including more passages and hence more questions from the Gates-MacGinitie Reading Test could possibly more reliably measure the two types of comprehension.

This study was only focused on the linguistic *knowledge* that underpins word-to-text integration without also considering integration *efficiency* or the facility with which the participants accessed that knowledge. In this respect, Schoonen and colleagues' studies (Cremer & Schoonen, 2013; Spätgens & Schoonen, 2018) are particularly noteworthy, despite their distinct focus from this study's. In those studies, knowledge availability and accessibility were differentiated; and participants' access to the semantic association or network knowledge was measured with time-sensitive tasks. Their approach and that of the present study can be integrated into future research to study word-to-text integration and reading comprehension (see also Oakhill et al.,

2015 on lexical facility or speed of access; and Zhang, 2012 on explicit vs. implicit grammatical knowledge). It would make more sense by examining knowledge concerning syntactic and semantic networks among words plays a significant role in building connections between propositions, which subsequently would improve comprehension. Furthermore, the efficient processing of meaning relations further would facilitate the comprehension process (Nagy & Scott, 2000).

It was a surprise in the present study that working memory did not significantly predict inferential comprehension. Theoretically, working memory is particularly important for inference generation and comprehension, because propositional meaning or text model information needs to be maintained there for knowledge to participate for situation model building or model integration (Kintsch, 1998; Zwaan & Rapp, 2006). In light of a lexically framed explanation of word-to-text integration and inference generation, words also need to be held in the working memory for lexical associates to be integrated for modifying and fine-tuning the situation model (Perfetti & Stafura, 2014; see also Hagoort, 2013). It was conjectured that this might be related to the narrow focus of the digit span test on storage as opposed to processing (and storage). In Alptekin and Erçetin (2011), where working memory significantly differentiated between readers with distinct levels of inferential comprehension, the reading span test required participants to not only recall sentence-final words but also make grammaticality judgment. The latter task requirement apparently involved a processing demand, not to mention the potential involvement of lexical and syntactic processes in the task. Future research may include different working memory components to study linguistic processes in inferential comprehension.

Finally, the findings were based on adult Arabic-speaking readers in a foreign language context. Future research is needed to test whether the findings are generalizable to other learner populations or contexts of learning (Fender, 2003). Another issue to explore in the future would be how the pattern may vary depending on learners' reading or general English proficiency. The performance of the participants in this study (see Table 5.1) suggests that their reading comprehension level tended to below: their average score was about eight out of 21 items. Although the present study found differential patterns for the two-word integration components

as a function of literal vs. inferential comprehension, it is clear from Tables 5.3-5.5 that vocabulary knowledge/size was still the dominant predictor of reading comprehension in those participants (see Jeon & Yamashita, 2014); the effect of word integration components, controlling for vocabulary size, was very small in size. Future research may explore the issues further in more advanced learners for whom a larger, unique effect of word-to-text integration might emerge, particularly that of semantic association for inferential comprehension.

5.7 Conclusions

The present study focused on two major components of word integration, that is, syntactic parsing and semantic association, and L2 reading comprehension; and assessed how syntactic and semantic network knowledge differentially predicted two types of text comprehension (literal vs. inferential) in adult EFL readers. Both types of knowledge were a significant, unique predictor of reading comprehension (disregarding the type of comprehension), after controlling for working memory and vocabulary knowledge/size. Yet, for literal comprehension, controlling for all other predictors, syntactic knowledge, as opposed to semantic network knowledge, was a significant predictor, whereas, for inferential comprehension, a converse pattern was found.

Taken together, these findings suggest that, while syntactic and semantic processes of word-to-text integration interplay and are both needed for successful text comprehension, different types of comprehension may place differential demand on these processes and their corresponding knowledge underpinnings. They also extend the current body of research on cognitive and linguistic processes of L2 reading comprehension, which tended to rely heavily on global measures of reading comprehension and thus have obscured an understanding about how these processes can and should be orchestrated in differential ways by the reader to cope with different levels of comprehension or tasks of reading. The theoretical significance underscored of lexical/semantic association for inference generation and inferential comprehension in light of the Reading Systems Framework (Perfetti & Stafura, 2014, 2015) and the Lexical Quality Hypothesis (Perfetti, 2007), in particular, provides a framework for researching and interpreting the role of

vocabulary depth/semantic network knowledge in L2 reading/inferential comprehension in the future. The present study invites L2 reading researchers to pay attention to inference driven by lower-order processes over and beyond the more widely known, knowledge-driven perspective.

Chapter 6. General Discussion and Conclusions

This chapter presents a summary of the main results of the two studies in this thesis. It also includes a general discussion of the results of the two studies, with particular reference to the theoretical framework and the existing literature. This is followed by some theoretical and pedagogical implications for both practice and policymakers to improve L2 textual comprehension in the context of both international and Saudi universities. It concludes with a discussion of the research limitations of the project, along with some recommendations for future research directions.

6.1 Summary of the Main Findings

The primary focus of the research was on lower-level processes of L2 reading comprehension, notably word recognition and word-to-text integration, and the underpinning aspects of knowledge and processing skills, with reference to adult Arabic-speaking EFL learners, a group that has been greatly underrepresented in the L2 reading literature. Several research questions were posed to guide the investigation of the distinct processes and these questions were answered through two separate studies based on a set of data drawn from the same group of participants. Despite the samples being essentially the same and some variables being used in both studies, the two studies served different purposes with a view to achieving a common goal in understanding the lower-level processes of L2 reading comprehension. In these two studies, a battery of tasks was administered to measure participants' reading comprehension, diverse lexical competences, grammatical knowledge, and working memory. The key findings of the two studies have been presented comprehensively and discussed in Chapters 4 and 5. They are briefly summarized in the following paragraphs.

Study 1 focused on the lexical basis of L2 reading comprehension in adult Arabic-speaking EFL readers by comparing the relative and collective contributions of distinct lexical competences. It notably considered lexical competence at both the lexical and the sub-lexical levels and emphasized the importance of both knowledge and processing efficiency (i.e. facility for accessing knowledge) in L2 reading comprehension. Hierarchical regression analyses revealed that the four lexical predictors, lexical and sub-lexical/morphological knowledge and lexical and sub-

lexical/morphological processing efficiency, collectively explained over 40% of the variance in the participants' reading comprehension. The knowledge predictors had a greater influence on reading comprehension than the processing efficiency predictors. When the knowledge predictors were not considered, sub-lexical/morphological processing efficiency, as opposed to lexical processing efficiency, significantly predicted reading comprehension, over and above working memory. Overall, among the four lexical competences, lexical knowledge was the strongest predictor, followed by sub-lexical knowledge and the processing efficiency predictors.

Study 2 focused primarily on two distinct components of word-to-text integration, that is, syntactic parsing and semantic association, and assessed how learners' syntactic and semantic network knowledge relatively predicted text comprehension and its types – literal vs. inferential – in L2 readers. A notable aspect that distinguished this study from the first was its emphasis on lower-level processes beyond word recognition. The focus on different types of textual comprehension also served as an opportunity to explore the complexity of the comprehension process in light of the different functioning of component skills. Both syntactic knowledge and semantic network knowledge were significant, unique predictors of reading comprehension regardless of the type of comprehension, after controlling for working memory and vocabulary knowledge/size. For literal comprehension, syntactic knowledge seemed to have a greater effect, whereas for inferential comprehension, the effect of semantic network knowledge seemed greater. In general, the findings suggest that in addition to the commonly held view of the importance of individual word recognition in L2 reading comprehension, word-to-text integration process in terms of its two components also play a distinct part in reading comprehension. These components have distinct roles in literal and inferential comprehension. Semantic network knowledge is crucial especially in cognitively more demanding reading tasks characterizing inferential reading.

Collectively, the findings of the two studies lead to the conclusion that L2 reading comprehension requires not only knowledge, including lexical, semantic and grammatical, but also the skills to access the knowledge efficiently. Depending on

the type of comprehension required based on the questions asked, lower-level processes may be involved in different ways and to different extents. This all confirms the complexity of the involvement of lower-level processes of L2 reading comprehension.

6.2 General Discussion

The results of the two studies in this thesis have been discussed in detail in Chapters 4 and 5, respectively. In the two chapters, the findings of each study were interpreted and their contribution to the literature was discussed in light of the particular research problem articulated in the respective study. This general discussion is not intended to revisit the individual research questions of the two studies, but rather aims to provide a broad discussion of some issues, based on the findings of the two studies, to show how this thesis has advanced understandings of L2 reading comprehension.

6.2.1 The Complex Nature of Reading Comprehension

The overall goal of this research was to examine the involvement of different lower-level processes in L2 reading comprehension and their underlying aspects of linguistic and processing skills. Taken together, the results of the two studies confirmed the complex nature of L2 reading comprehension discussed in Chapter 2 in terms of the concurrent execution of a number of processes. The empirical evidence in this research provides support for theoretical frameworks of text comprehension, notably the Construction–Integration Model (Kintsch,1988) and the Reading Systems Framework (Perfetti, 1999), in considering the contributions of several linguistic processes to reading comprehension. Moreover, the componential approach (Carr et al., 1990) was adopted in both studies to disentangle the complex involvement of diverse knowledge types and skills (for more details see Chapters 3 and 4) with a focus on lower-level processes in L2 reading comprehension. These lower-level processes are complex in that they rely on the interplay of diverse linguistic knowledge, including sub-lexical/morphological knowledge, vocabulary knowledge/size, semantic network knowledge and grammatical knowledge, and their corresponding processing skills.

Firstly, word recognition process of reading comprehension was examined as the focus of study 1. This process entails several aspects of lexical and sub-lexical

knowledge and processing skills. Specifically, study 1 revealed that lexical knowledge (i.e. knowledge of the form–meaning connection) uniquely explained 16.5% of the variance in reading comprehension, and sub-lexical knowledge (i.e. knowledge of English affixation: form, meaning and function) also uniquely explained 4% of the variance in reading comprehension over and beyond the other variables that were entered in the regression model. However, sub-lexical and lexical processing efficiency (i.e. separability and combinability decision tasks, and the lexical decision task, respectively) did not uniquely explain a significant proportion of variance in reading comprehension over and beyond the rest of the variables when they were all entered in the regression model of the analysis.

Study 2 further confirmed the complex nature of L2 reading comprehension by going beyond word recognition to examine distinct components of word-to-text integration. Investigating this process also added a further layer of complexity to understanding L2 reading comprehension by assessing different aspects of linguistic knowledge, notably semantic network and syntactic knowledge, for reading comprehension and how these aspects of knowledge inform syntactic parsing and semantic association. For instance, over and beyond the vocabulary size and working memory that were entered in the regression model, semantic network knowledge uniquely explained 1.5% of the variance in reading comprehension while syntactic knowledge uniquely explained 1.7%. The distinction between literal and inferential comprehension, which was a core focus of Chapter 5, adds yet another layer of complexity to the issue of linguistic processes in reading comprehension. That is, the relative roles of different aspects of linguistic knowledge vary as a function of the type of comprehension.

Of the many factors influencing reading comprehension, lexical knowledge (or vocabulary size) played the predominant role. Without initial knowledge of the words in a certain text or lexical access, word-to-text integration would not be possible. Yet, knowing a large number of words without knowledge of their associations would not be sufficient for comprehension. Across the two studies, the findings emphasized the relationship between word knowledge and reading comprehension in different respects: sub-lexical, lexical, and semantic network knowledge. This is in line with some theories, such as the Instrumentalist Hypothesis proposed by Anderson and

Freebody (1981), which postulates that lexical knowledge is a major causal factor directly impacting one's comprehension of text, and also the Lexical Quality Hypothesis (Perfetti, 2007), which underscores lexical quality (or vocabulary depth) for comprehension. The finding concerning the greater involvement of semantic network knowledge in inferential comprehension than in literal comprehension, which is line with predictions in the Reading Systems Framework (Perfetti & Stafura, 2014), in particular, has enriched our knowledge of the lexical basis of L2 reading comprehension.

6.2.2 Distinction between Knowledge and Processing Skills

A notable issue, and a niche in the L2 reading literature, considered in this thesis was the distinction between linguistic knowledge and processing skills. Although *knowledge* of diverse linguistic elements is fundamental to reading comprehension, the associated *processing* skills also play an essential role in reading comprehension, particularly in the consideration that the ultimate goal of reading is smooth and efficient text comprehension. Being able to access different aspects of linguistic knowledge in an efficient manner is related to but distinct from the aspects of knowledge themselves. Both should be important in L2 reading comprehension.

As discussed in Chapter 2, L2 researchers have theoretically conceptualized and empirically studied processing skills (i.e. fluency or accessibility) as a distinct dimension of linguistic competence parallel to the knowledge facet because knowing a word entails the competence to recognize it as well as to access its meaning within a fraction of a second (Nagy & Scott, 2000; Perfetti & Hart, 2002). There has been a strong emphasis on linguistic *knowledge* in L2 reading comprehension research with very limited attention to skills associated with accessing the knowledge efficiently during reading. Interesting, however, the second language acquisition literature shows a particularly strong interest in linguistic *processing*. This thesis (Chapter 4; Study 1) addressed that gap between the L2 reading and SLA literature by attending to distinct aspects of linguistic knowledge as well as their corresponding processing skills. Chapter 4 of this thesis focused on the knowledge vs. processing distinction largely the context of word recognition in L2 reading comprehension. Semantic and grammatical processing efficiency, as opposed to semantic and

grammatical knowledge, however, were not included Study 2 or Chapter 5. This is certainly a limitation (see 6.4 Research Limitations and Future Research Directions). Hypothetically, though, semantic and grammatical processing efficiency would also contribute to reading comprehension, which should be an issue for testing in future research.

6.2.3 Modulation by Types of Textual Comprehension

The RAND (RAND Reading Group, 2002) heuristic for understanding comprehension suggests that there are differences over and beyond reader factors or individual differences, which further complicate the issue of reading comprehension, including the involvement of linguistic processes. Thus, to understand reading comprehension, it is important to address the types and goals of comprehension or to go beyond inter-individual factors or individual differences to address intra-individual variations across different situations of reading.

An issue of importance addressed in this thesis was thus how contributions of different linguistic knowledge to L2 reading comprehension may be modulated by type of textual comprehension. Researchers have documented several types or levels of comprehension (Kintsch, 1988, 1998). To understand a text, the reader needs to be engaged with linguistic processing of surface-level textual features, which is the literal level of comprehension. Literal comprehension is characterized by being able to find information explicitly stated in a text. To achieve this level, readers identify individual words in a sentence and establish the sentence's propositional meaning by applying knowledge of the grammatical structure. This process gradually paves the way to the construction of a text's microstructure, which further includes relating propositions that are in close proximity in the text to form a coherent semantic whole. This constitutes the inferential level of understanding (Alptekin & Erçetin, 2011). Inferential comprehension requires higher-order cognitive skills, such as inferencing skills and background knowledge, in addition to basic language skills (e.g., semantic processing and association), so the reader can go beyond the explicit meaning of the text to infer or interpret messages between lines.

These two types of reading comprehension can involve linguistic knowledge and skills in differential ways, as discussed in Chapter 2 and confirmed in Study 2 reported in Chapter 5. This issue has received little attention in existing literature on L2 reading comprehension (Choi & Zhang, 2020). For instance, the sub-types of reading comprehension were not considered in the moderator analysis in Jeon and Yamashita's (2014) meta-analysis of linguistic correlates of L2 reading comprehension. Choi and Zhang (2020), on the other hand, pointed out that the relative contribution of vocabulary and grammatical knowledge can be modulated by different types of reading comprehension. This should be a direction for future research (see later section on limitations and future directions in Chapter 6). The complexity of intra-individual variations of course does not pertain to type of comprehension only. Text types could also have an impact on involvement of linguistic process in L2 reading comprehension, which is discussed later in Section 6.4.1.

6.2.4 Role of Working Memory in Reading Comprehension

Although working memory was largely considered as a control variable or covariate in the two studies, it is of importance to discuss its role in L2 reading comprehension. There is a broad agreement on the crucial role of working memory for textual comprehension and for management of lower-level processes in terms of both capacity and processing (see Chapter 2). Nevertheless, it has not often been considered in studies on L2 reading comprehension either as a core predictor or a covariate for studying linguistic processes.

In study 1 (Chapter 4), working memory was entered first into the regression equation as a covariate and explained about 2.9% of the variance in reading comprehension, followed by different lexical competences entered individually or as a block. In the regression analyses in study 2, working memory explained a small but significant proportion of variance in over comprehension (2.8%) as well as literal comprehension (3.4%) when first entered in the models. This overall lends support to the important role of working memory in L2 reading comprehension. It also suggests that controlling for working memory is important for studying linguistic

processes of L2 reading comprehension, particularly when speed of linguistic processing such as in the case of Study 1 was considered.

Working memory, however, was not found to significantly correlate with or predict inferential comprehension in Study 2. This might because of the focus on the capacity employing digit span task as opposed to processing aspect of working memory. Making local inferences is one of the higher-level cognitive processes that requires more than recall ability. This is in line with a recent meta-analysis of 25 primary studies that examined the relationship between L2 reading comprehension and working memory by Shin (2020). It has been found that the degree to which working memory is involved in L2 reading comprehension vary depending on the type of reading task (Shin, 2020). This issue was discussed in Chapter 5 and will be revisited later in 6.4.2 on research limitations and future directions.

6.3 Theoretical and Pedagogical Implications and Recommendations

This section presents the theoretical and potential pedagogical implications of the two studies, providing recommendations for learning and teaching L2 reading skills, particularly in EFL contexts. The following presentation aims to bridge the gap between theory and practice in L2/EFL reading and language acquisition.

6.3.1 Theoretical Implications

Theoretically, this research contributes to current understandings of the lower-level processes of reading comprehension by considering the relative and collective contributions of diverse linguistic knowledge as well as processing skills (e.g. sub-lexical, morphological processing) to (different types of) reading in adult L2 learners, specifically EFL learners in the Arabic-speaking world. It has filled an important gap in the current literature on L2 reading comprehension where few studies focused on Arabic-speaking EFL readers.

The findings derived from the two studies particularly highlight the importance of considering lexical quality in research on L2 reading comprehension, such as morphological knowledge and processing for efficient word recognition in study 1 and semantic network knowledge in light of its contribution to word-to-text integration and inferential comprehension in study 2. The findings reported on the differential

contributions of syntactic knowledge and semantic network knowledge to different types of comprehension have also enriched current understandings about the complexity of L2 reading comprehension, particularly lower-level processes and their underlying linguistic knowledge and skills. They call for future research to consider both inter-individual/reader and intra-individual/reader variations in L2 reading comprehension.

6.3.2 Pedagogical Implications and Recommendations for Practice

While this research was not designed to be pedagogical in focus, its results could have some useful implications for instruction. These implications of course await future instruction-oriented research to assess their validity for subsequent translation into L2 reading curriculum and classroom instruction (Grabe, 2009). Firstly, the central role of the lexicon in textual comprehension is well-supported in this research. Although vocabulary size is arguably fundamental to reading comprehension, knowing the (partial) meaning of a large number of words is insufficient. Quality of lexical knowledge, as argued in the literature (Nation, 2001; Qian, 2002; Read, 2004) and supported by the two studies of this thesis, should be promoted in EFL reading instruction. Diverse aspects of lexical knowledge could each make distinct contribution to the comprehension process. Thus, highlighting these different aspects of knowledge related to lexical quality warrants considerable attention in the EFL curriculum and classroom teaching to develop learners' reading comprehension skills. Developing rich word knowledge should be an essential goal, as has been consistently underscored in the literature on L2 reading instruction (Grabe & Stoller, 2020). There has been experimental evidence on the benefits of high-quality word instruction on students' reading comprehension development, beyond the development of word knowledge itself (e.g. Beck, Perfetti & McKeown, 1982; Wright & Cervetti, 2017).

Specifically, the unique contribution of morphological knowledge to reading comprehension suggests that it also deserves instructional attention (Ke & Zhang, in press). Particularly, the relative strength of the correlations of the three affix tasks with reading comprehension suggests that affix meanings and grammatical functions are particularly important in reading instruction. These insights are also fundamental

in addressing word learning / lexical inferencing and vocabulary development (Zhang & Koda, 2012) Although most studies have tended to focus on young ESL or bilingual learners of English (Ke & Zhang, in press), there seems to be an agreement, in the wider English Language teaching (ELT) community, on the value of enhancing learners' knowledge of morphological features to develop their vocabulary and reading skills. In their instruction, teachers could, for example, draw students' attention to how an affix may change the word class of a base word (e.g., *-less* is added to a noun such as *home* and creates an adjective, that is, *homeless*) and create activities for students to segment words into their morphological components and practise inferring the meaning of those words (e.g., *home/less* → *without home*).

Another important implication of this research for practice is the effect of processing efficiency at different levels of lexical knowledge. Even though the effect of (sub-) lexical processing skills was very small compared to that of lexical and morphological knowledge in study 1, efficient processing of written words, or word recognition efficiency, deserves attention in the foreign language curriculum and pedagogy. More instructional attention should be directed to lexical processing skills (or fluency training for lower-level skills in general), given that the purpose of learning vocabulary is not merely to increase the number of words one knows but also to improve competence in accessing them efficiently to meet the goal of reading comprehension. In particular, the comparison of the morphological and lexical processing efficiency measures in the study, which was discussed in light of their potentially different psycholinguistic processes, suggests that training in word recognition should be much more than for increasing the speed of word recognition (or parts of words) out of context (Fukkink et al., 2005). Accessing meaning efficiently, especially integrating word meaning efficiently, is fundamental (Perfetti, 2010; Perfetti & Stafura, 2014). In this respect, contextualized (sub-)lexical processing, such as extensive reading, is essential (Grabe, 2009; Grabe & Stoller, 2019). While efficient word recognition is important for reading comprehension, conversely achieving this depends on wide reading to provide contextualized, meaning-focused lexical experiences. Thus, developing these skills deserves attention from curriculum developers in developing the foreign language curriculum,

and from teachers and learners in foreign language pedagogy. Programs or teachers should offer L2 readers extensive reading practice using different sources and promote word recognition fluency through repeated reading of texts (Grabe, 2009; Taguchi et al., 2004).

Syntactic knowledge, in light of its importance for word-to-text integration and structure building, is also important. Perhaps more importantly, explicit instructional attention needs to be given to building and consolidating learners' semantic network knowledge or vocabulary depth. This type of knowledge has long been emphasized in L2 vocabulary teaching (and assessment) (Nation, 2001; Read, 2000). However, the theoretical basis on which the importance of such knowledge has been argued is empirically confirmed in this thesis in terms of semantic integration and inference generation, providing new insights into why this knowledge is important and how it might be promoted in L2 learners. In a recent study, Raudszus et al. (2019) adopted a "pathfinder networks" approach to measuring L1 and L2 readers' textbase memory and ability to build a situation model. Essentially, participants were asked to read a text and work on the computer to drag and organize words/concepts from the text to show how they thought they were more or less closely related. Although this network-building approach was adopted as a research paradigm, it may well also have valuable pedagogical benefits as it is contextualized in a text reading activity. It could integrate various goals for L2 vocabulary learning and reading instruction (especially instruction to promote inferential comprehension development) (see Grabe, 2009; Grabe & Stoller, 2019). Other instructional strategies such as semantic mapping, which is a visual strategy drawing upon students' background knowledge could also be used to facilitate students' development of semantic association between words (e.g., Khoii & Sharififar, 2013).

6.4 Research Limitations and Future Research Directions

Generalizing the findings of this research requires consideration of the research limitations. Each study in this research has its own limitations, as addressed earlier in Chapters 4 and 5. This section discusses the limitations of the research overall, which could in turn provide directions for future studies. Most importantly, it must be acknowledged that no single study could accommodate all these issues

simultaneously. In other words, there are necessarily limitations in this research, and in all studies, as accommodating all these dimensions would be overly ambitious given the complexity discussed earlier of reading comprehension.

6.4.1 Text Types

An important caveat in this research is the lack of regard for the types of texts when examining the roles of different linguistic processes in reading comprehension. Text type is a distinct dimension to consider for researching and understanding reading comprehension (see RAND heuristic, Figure 2.1). Examining the (relative) roles of diverse aspects of linguistic knowledge in relation to different text types would be important in L2 reading research. The instrument used to measure reading comprehension was the Gates–MacGinitie Reading Test, as previously indicated, which is a standardized test originally designed to include both narrative and informational types of text. Although these two genres were included in assessing the participants' reading comprehension skills, no distinction in terms of text type, in addition to that between types of comprehension, was included in the analysis given the relatively small number of items in the test. A comparison between these two types could generate important results to obtain a more nuanced understanding of the relative contributions of different linguistic processes in reading comprehension. For example, compared to narrative texts, informational texts are lexically denser with more derivational words and generally considered more difficult (McNamara, Graesser & Louwerse, 2012). This difference in lexical properties perhaps suggests that morphological knowledge and processing might make a greater contribution to informational than to narrative texts. Future research should consider more precise classifications of reading comprehension taking account of different text types.

6.4.2 Processing Dimension of Working Memory

Working memory is fundamental to reading comprehension (Jones, 2018). Without working memory, no knowledge (e.g. phonological, vocabulary, grammar) stored in the long-term memory can be rendered into a form available for interaction with other processes, and therefore comprehension could not be achieved (Grabe, 2009). This suggests the direct and well-established role of working memory in holding linguistic knowledge to enable successful and fluent reading.

Working memory was found to correlate highly with L1 reading skills (Harrington & Sawyer, 1992). However, a meta-analysis of L2 reading comprehension studies found it presented a low correlation with L2 reading comprehension (Jeon & Yamashita, 2014). Measures of working memory could be focused on its different dimensions, that is capacity vs. processing, and can thus be a reason for the different findings on its role in reading comprehension.

A limitation of this thesis is the lack of consideration for the aspect of processing when measuring the working memory construct, which might have obscured understandings about the role of working memory in L2 text comprehension. In other words, it may be the processing aspect of working memory rather than the capacity aspect that has a more salient role in reading comprehension, specifically inferential comprehension. A meta-analysis of 77 studies that investigated the association between working memory capacity and language comprehension ability supported the proposition that measures tapping the processing as well as storage capacity aspects of working memory in combination (e.g. reading span, listening span) are better predictors of comprehension than are measures that tap only the storage capacity (e.g. word span, digit span) (Daneman & Merikle, 1996). In addition, the meta-analysis showed that the mathematical process plus storage measures of working memory are good predictors of comprehension. Measuring readers' ability to store and process information through tasks that tap complex span is recommended in future studies on reading comprehension skills (e.g. Currie & Cain, 2015).

6.4.3 Longitudinal Data

The relative contributions of different linguistic knowledge and processing skills to reading comprehension can vary depending on learners' L2 proficiency or the stage of L2 learning. Some L2 reading researchers (e.g. Cremer & Schoonen, 2013; Shiotsu, 2010; Shiotsu & Weir, 2007) split their samples of readers into "proficient" and "less proficient" subgroups and aimed to examine if any patterns would differ between the subgroups. This research did not perform such ad hoc grouping because the participants came from the same student population and were at a

similar proficiency level. Future research may recruit and compare learners with distinct levels of language proficiency or at distinct developmental stages.

Longitudinal data would be particularly useful. Not only can longitudinal data allow comparisons of relationships, patterns and strengths of associations between linguistic knowledge and skills and reading comprehension across developmental stages, but they would allow testing of the reciprocal relation between the development of L2 knowledge and processing skills and reading abilities; that is, the extent to which linguistic knowledge and skills contribute to reading development, and conversely reading abilities predict the development of linguistic knowledge and skills. In the L2 literature, there are notable research gaps in collecting longitudinal data to examine reading and language *development*.

Addressing the aforementioned issues and research gaps was actually part of the planning for this thesis. Specifically, a second data collection stage was planned for the academic term starting in January 2020 (which was about an academic year after the first wave of data or the data reported in this thesis were collected). The second wave of data was planned for comparing the relative contributions of different types of linguistic knowledge and processing skills to reading comprehension among the same participants over a period of about one year. The second stage was actually started towards the end of February 2020, but only a small percentage of the participants (around 30 or 10%) had completed some of the tests administered in stage 1 before data collection had to be discontinued due to the spread of the coronavirus (Covid-19) around the world and the announcement of the pandemic by the World Health Organization (WHO, 2020), which greatly affected educational institutions, among others. Shortly thereafter, governments established new rules to mitigate the spread of infection in their countries, including Saudi Arabia. One such decision was suspending face-to-face teaching and learning in schools and universities from March 2020. This emerging situation led to a sudden unplanned shift to remote methods of teaching and learning, which then stalled the plan for the second phase of data collection.

6.4.4 Cross-Linguistic Transfer

L2 reading necessaries involves two languages (Koda, 2005). Examining L2 reading comprehension skills implies a need to consider a critical factor in addition to L2 linguistic knowledge and skills, namely the influence of the L1 (see Yamashita & Shiotsu, 2017). Indeed, the influence of the L1 on L2 reading is one of the central issues in L2 reading research (Jeon & Yamashita, 2014, Koda, 2005). Although current theorizations of subskills for reading comprehension are largely situated in the L1 context, much should pertain also to L2 reading comprehension (Grabe, 2009). There are reading skills and strategies that are "not language-specific" or are "universally" important, disregarding learners' L1 backgrounds. In other words, these skills and strategies can be transferred from L1 to L2 reading.

The potential for crosslinguistic transfer of L1 reading has inspired researchers to investigate whether difficulties with reading in an L2 arise more from the reader's lack of linguistic knowledge of the L2 or other general reading processes (Alderson, 1984; Bernhardt & Kamil, 1995; Wurr, 2003). Researchers have investigated the Language Threshold Hypothesis proposed by Cummins (2000), which suggests that a certain level of L2 proficiency is necessary for transfer to happen. This possibility was further examined in the moderator analyses conducted by Jeon and Yamashita (2014) in their meta-analysis, revealing that studies of the role of the L1 in L2 reading comprehension showed mixed results (e.g. Proctor et al., 2005; Proctor et al., 2012). It seems that overall L1 reading can be transferred to facilitate reading comprehension in the L2; yet there are conditions for the transfer to happen. Given the goal of this thesis, the participants' L1 Arabic reading was not considered in the design of the two studies. This issue certainly deserves more attention in future studies of L2 reading comprehension where L1 reading and L2 linguistic knowledge and skills can be both measured for comparing their relative contributions (Yamashita & Shiotsu, 2017).

6.5 Conclusions

This thesis focuses on examining how various linguistic knowledge and processing skills predict EFL reading comprehension based on their correlational associations in Arabic-speaking EFL learners. Following the componential approach to reading,

the two studies employed several quantitative data collection methods, both paper-based and computer-based with a battery of tests administered, on a group or individual basis, to measure the participants' lexical competences, syntactic knowledge, reading comprehension ability, and working memory. Data were collected from a total of 268 Arabic-speaking EFL learners in a Saudi university, representing a range of undergraduate majors.

Study 1 compared how different lexical competences, including lexical knowledge and processing skills, at both the word/lexical and sub-lexical/morphological levels, would predict reading comprehension. Hierarchical regression analyses revealed that over and above working memory, both lexical and sub-lexical knowledge were significant and unique predictors of reading comprehension, and sub-lexical processing efficiency, as opposed to lexical processing efficiency, significantly predicted reading comprehension. In addition, among the lexical competences measured, lexical knowledge was the strongest predictor; the two knowledge variables collectively had a far greater influence on reading comprehension than the two processing efficiency variables.

Study 2 focused on two components of word integration – syntactic parsing and semantic association – and assessed how syntactic and semantic network knowledge differently predicted two types of textual comprehension (literal vs. inferential) in L2 readers. Multiple regression analyses showed that both syntactic and semantic network knowledge significantly predicted reading comprehension (disregarding the type of comprehension), controlling for working memory and vocabulary knowledge. Syntactic knowledge, as opposed to semantic network knowledge, was a significant, unique predictor of literal comprehension, whereas a converse pattern was found for inferential comprehension.

The results of both studies collectively have added insights to lower-level processes of L2 reading comprehension, particularly in light of lexical quality and word-to-text integration, which has received limited attention in the literature on adult EFL readers. The research further provides some theoretical and pedagogical implications. In concluding this thesis, several limitations were noted to be addressed in future studies, such as including the processing aspect when assessing working

memory and conducting longitudinal research to understand how the involvement of different linguistic processes in L2 reading comprehension as readers' general proficiency develops over time.

References

Aitchison, J. (2012). *Words in the mind: An introduction to the mental lexicon* (4th ed.). Wiley-Blackwell.

Alderson, J. C. (1984). Reading in a foreign language: A reading problem or a language problem. *Reading in a foreign language*, *1*, 24.

Alderson, J. C. (2000). *Assessing reading*: Ernst Klett Sprachen.

Alderson, J. C. (2005). *Diagnosing foreign language proficiency: The interface between learning and assessment*: A&C Black.

Al-Nifayee, A. M. (2010). The Effectiveness of the Instrumental Enrichment Approach on the Enhancement of Reading Comprehension Skills of Preparatory Stage Pupils with English Language Learning Difficulties. Online Submission.

Alptekin, C., & Erçetin, G. (2009). Assessing the relationship of working memory to L2 reading: Does the nature of comprehension process and reading span task make a difference? *System, 37*(4), 627-639. https://doi.org/10.1016/j.system.2009.09.007

Alptekin, C., & Erçetin, G. (2010). The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. *Journal of Research in Reading, 33*(2), 206-219. https://doi.org/10.1111/j.1467-9817.2009.01412.x

Alptekin, C., & Erçetin, G. (2011). The effects of working memory capacity and content familiarity on literal and inferential comprehension in L2 reading. *TESOL Quarterly, 45*(2), 235–265. https://doi.org/10.5054/tq.2011.247705

Anderson, R. C., & Freebody, P. (1981). Vocabulary knowledge. In T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 77–117). Newark. DE: International Reading Association.

Anderson, R. C., & Pearson, P. D. (1984). A schema-theoretic view of basic processes in reading. In P.D. Pearson (Ed.), *Handbook of reading research* (pp. 255–291). New York: Longman.

Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2009). Introduction to Research in Education (pp 426–427). *Wadsworth: Engaged Publishing*.

Babayiğit, S. (2015). The relations between word reading, oral language, and reading comprehension in children who speak English as a first (L1) and

second language (L2): A multigroup structural analysis. *Reading and Writing, 28*(4), 527-544. https://doi.org/10.1007/s11145-014-9536-x

Baddeley, A. (2003). Working memory and language: An overview. *Journal of communication disorders*, *36*(3), 189-208. https://doi.org/10.1016/S0021-9924(03)00019-4

Baddeley, A. (2007). *Working memory, thought, and action*. Oxford: Oxford University Press.

Beck, I. L., Perfetti, C. A., & McKeown, M. G. (1982). Effects of long-term vocabulary instruction on lexical access and reading comprehension. *Journal of educational psychology*, *74*(4), 506. https://doi.org/10.1037/0022-0663.74.4.506

Beglar, D., & Hunt, A. (1999). Revising and validating the 2000-word level and university word level vocabulary tests. *Language testing*, *16*(2), 131-162.

BERA. (2018). *Revised ethical guidelines for educational research*. British Educational

Bernhardt, E. B. (2010). *Understanding advanced second-language reading*: Routledge.

Bernhardt, E. B., & Kamil, M. L. (1995). Interpreting relationships between L1 and L2 reading: Consolidating the linguistic threshold and the linguistic interdependence hypotheses. *Applied linguistics*, *16*(1), 15-34.

Bishop, D. V., & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. *Journal of child psychology and psychiatry*, *31*(7), 1027-1050. https://doi.org/10.1111/j.1469-7610.1990.tb00844.x

Bowers, P.N., Kirby, J.R., & Deacon, S.H. (2010). The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research, 80*, 144–179. https://doi.org/10.3102/0034654309359353

Breznitz, Z. (2006). *Fluency in reading: Synchronization of processes*. Routledge.

Bryman, A. (2016). *Social research methods*. Oxford university press.

Bryman, A., & Bell, E. (2011). Ethics in business research. *Business Research Methods*, *7*(5), 23-56.

Burgoyne, K., Kelly, J. M., Whiteley, H. E., & Spooner, A. (2009). The comprehension skills of children learning English as an additional language. *British Journal of Educational Psychology, 79*(4), 735-747. https://doi.org/10.1348/000709909X422530

Cain, K., & Barnes, M. A. (2017). Reading comprehension: What develops and when? In K. Cain, D. L.Compton, & R. K. Parrila (Eds.), *Theories of reading development* (pp. 257–282). Amsterdam: John Benjamins Publishing. https://doi.org/10.1075/swll.15.15cai

Cain, K., & Nash, H. M. (2011). The influence of connectives on young readers' processing and comprehension of text. *Journal of Educational Psychology, 103*(2), 429. https://doi.org/10.1037/a0022824

Cain, K., & Oakhill, J. (2012). Reading comprehension development from seven to fourteen years: Implications for assessment. *Measuring up: Advances in how we assess reading ability, 59*, 76.

Cain, K., & Oakhill, J. (2014). Reading comprehension and vocabulary: Is vocabulary more important for some aspects of comprehension? *L'Année Psychologique, 114*(4), 647–662. https://doi:10.4074/S0003503314004035

Cain, K., Oakhill, J., & Bryant, P. (2004). Children's reading comprehension ability: Concurrent prediction by working memory, verbal ability, and component skills. *Journal of Educational Psychology, 96*(1), 31–42. https://doi.org/10.1037/0022-0663.96.1.31

Calvo, M. G. (2001). Working memory and inferences: Evidence from eye fixations during reading. *Memory*, *9*(4-6), 365-381. https://doi.org/10.1080/09658210143000083

Carlisle, J. F. (2003). Morphology matters in learning to read: A commentary. *Reading Psychology*, *24*(3-4), 291-322. https://doi.org/10.1080/02702710390227369

Carr, T. H., Brown, T. L., Vavrus, L. G., & Evans, M. A. (1990). Cognitive skill maps and cognitive skill profiles: Componential analysis of individual differences in children's reading efficiency.

Carrell, P.L. & W. Grabe (2002). “Reading”. In N. Schmitt (ed), An introduction to applied linguistics. London

Carson, D., Gilmore, A., Perry, C., & Gronhaug, K. (2001). *Qualitative marketing research*. Sage.

Choi, Y., & Zhang, D. (2018). The relative role of vocabulary and grammatical knowledge in L2 reading comprehension: a systematic review of literature, *International Review of Applied Linguistics in Language Teaching* (published online ahead of print 2018). doi: https://doi.org/10.1515/iral-2017-0033

Chrysochoou, E., Bablekou, Z., & Tsigilis, N. (2011). Working memory contributions to reading comprehension components in middle childhood children. *The American journal of psychology*, *124*(3), 275-289. doi:10.5406/amerjpsyc.124.3.0275

Clahsen, H., Felser, C., Neubauer, K., Sato, M., & Silva, R. (2010). Morphological structure in native and nonnative language processing. *Language Learning, 60*, 21–43. https://doi.org/10.1111/j.1467-9922.2009.00550.x

Cohen, L., Manion, L. & Morrison, K. (2018). *Research methods in education* (8th ed.). New York: Routledge Publication.

Conrad, N. J. (2008). From reading to spelling and spelling to reading: Transfer goes both ways. *Journal of Educational Psychology*, *100*(4), 869. https://doi.org/10.1037/a0012544

Crain, S., & Shankweiler, D. (1990). *Explaining failures in spoken language comprehension by children with reading disabilities.* In D. A. Balota, G. B. Flores d'Arcais, & K. Rayner (Eds.), *Comprehension processes in reading* (p. 539–555). Lawrence Erlbaum Associates, Inc.

Cremer, M. (2013). *Accessing word meaning: Semantic word knowledge and reading comprehension in Dutch monolingual and bilingual fifth-graders*. Netherlands Graduate School of Linguistics.

Cremer, M., & Schoonen, R. (2013). The role of accessibility of semantic word knowledge in monolingual and bilingual fifth-grade reading. *Applied Psycholinguistics, 34*(6), 1195–1217. https://doi.org/10.1017/S0142716412000203

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda (Maryland): National Institutes of Health*, *2013*, 541-545.

Crossley, S. A., Greenfield, J., & McNamara, D. S. (2008). Assessing text readability using cognitively based indices. *TESOL Quarterly*, *42*(3), 475–493. https://doi.org/10.2307/40264479

Crosson, A. C., & Lesaux, N. K. (2013). Does knowledge of connectives play a unique role in the reading comprehension of English learners and English-only students? *Journal of Research in Reading, 36*, 241–260. https://doi.org/10.1111/j.1467-9817.2011.01501.x

Crotty, M., & Crotty, M. F. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Cummins, J. (2000). *Language, power, and pedagogy: Bilingual children in the crossfire* (Vol. 23): Multilingual Matters.

Cunningham, A. E., Perry, K. E., & Stanovich, K. E. (2001). Converging evidence for the concept of orthographic processing. *Reading and writing*, *14*(5-6), 549-568.

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods, 1*, 16–29. https://doi.org/10.1037/1082-989X.1.1.16

Currie, N. K., & Cain, K. (2015). Children's inference generation: The role of vocabulary and working memory. *Journal of Experimental Child Psychology, 137*, 57–75. https://doi.org/10.1016/j.jecp.2015.03.005

Curtis, W., Murphy, M., & Shields, S. (2013). *Research and education*. Routledge.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic bulletin & review*, *3*(4), 422-433. https://doi.org/10.3758/BF03214546

Deacon, S. H. (2012). Sounds, letters and meanings: The independent influences of phonological, morphological and orthographic skills on early word reading accuracy. *Journal of Research in Reading*, *35*(4), 456-475. https://doi.org/10.1111/j.1467-9817.2010.01496.x

Dörnyei, Z. (2007). *Research Methods in Applied Linguistics: Quantitative, Qualitative, and Mixed Methodologies*: OUP Oxford.

Droop, M., & Verhoeven, L. (2003). Language proficiency and reading ability in first-and second-language learners. *Reading research quarterly*, *38*(1), 78-103. https://doi.org/10.1598/RRQ.38.1.4

Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2012). *Management research*. Sage.

Farnia, F., & Geva, E. (2013). Growth and predictors of change in English language learners' reading comprehension. *Journal of Research in Reading, 36*(4), 389-421. https://doi.org/10.1111/jrir.12003

Farran, L. K., Bingham, G. E., & Matthews, M. W. (2012). The relationship between language and reading in bilingual English-Arabic children. *Reading and Writing, 25*, 2153–2181. https://doi.org/10.1007/s11145-011-9352-5

Fender, M. (2001). A review of L1 and L2/ESL word integration skills and the nature of L2/ESL word integration development involved in lower-level text processing. *Language Learning, 51*(2), 319–396. https://doi.org/10.1111/0023-8333.00157

Fender, M. (2003). English word recognition and word integration skills of native Arabic- and Japanese-speaking learners of English as a second language. *Applied Psycholinguistics, 24*(2), 289–315. https://doi.org/10.1017/S014271640300016X

Fukkink, R. G., Hulstijn, J., & Simis, A. (2005). Does training in Second-Language word recognition skills affect reading comprehension? An experimental study. *Modern Language Journal, 89*, 54–75. https://doi.org/10.1111/j.0026-7902.2005.00265.x

García, J. R., & Cain, K. (2014). Decoding and reading comprehension: A meta-analysis to identify which reader and assessment characteristics influence the strength of the relationship in English. *Review of Educational Research, 84*, 74–111. https://doi.org/10.3102/0034654313499616

Garnham, A., & Oakhill, J. (1996). The mental models theory of language comprehension. *Models of understanding text*, 313-339.

Gavin, H. (2008). *Understanding research methods and statistics in psychology*. Sage.

Georgiou, G. K., Parrila, R., Kirby, J. R., & Stephenson, K. (2008). Rapid naming components and their relationship with phonological awareness, orthographic knowledge, speed of processing, and different reading outcomes. *Scientific Studies of Reading*, *12*(4), 325-350. https://doi.org/10.1007/s11145-007-9096-4

Gibson, E. (1998). Linguistic complexity: Locality of syntactic dependencies. *Cognition*, *68*(1), 1-76. https://doi.org/10.1016/S0010-0277(98)00034-1

Given, T. (1995). Coherence in text vs. coherence in mind. *Coherence in spontaneous text, 31*, 59.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and special education, 7*(1), 6-10. https://doi.org/10.1177/074193258600700104

Grabe, W. (2005). The role of grammar in reading comprehension. In J. Frodesen & C. Holton (Eds.), *The power of context in language teaching and learning* (pp. 268 –282). Boston: Heinle & Heinle.

Grabe, W. (2009). *Reading in a second language: Moving from theory to practice*. Cambridge, MA: Cambridge University Press.

Grabe, W. (2014). Key issues in L2 reading development. In *Proceedings of the 4th CELC Symposium for English Language Teachers-Selected Papers* (pp. 8-18).

Grabe, W., & Stoller, F. L. (2019). *Teaching and researching reading* (3rd ed.). New York, NY: Routledge.

Gray, W. S. (1960). The major aspects of reading. *Sequential development of reading abilities*, *90*, 8-24.

Greener, I. (2011). *Designing social research: A guide for the bewildered*. Sage Publications.

Greidanus, T., & Nienhuis, L. (2001). Testing the quality of word knowledge in a second language by means of word associations: Types of distractors and types of associations. *The Modern Language Journal*, *85*(4), 567-577. https://doi.org/10.1111/0026-7902.00126

Greidanus, T., Bogaards, P., van der Linden, E., Nienhuis, L., & de Wolf, T. (2004). The construction and validation of a deep word knowledge test for advanced learners of French. *Vocabulary in a second language: Selection, acquisition, and testing*, 191-208.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research*, *2*(163-194), 105.

Guy, S., & Ingram, J. C. (2009). Neurolinguistics: An Introduction to Spoken Language Processing and Its Disorders. *Journal of the International Neuropsychological Society: JINS*, *15*(1), 162. DOI:10.1017/S1355617708090280

Hagoort, P. (2005). On Broca, brain, and binding: a new framework. *Trends in cognitive sciences, 9*(9), 416-423. https://doi.org/10.1016/j.tics.2005.07.004

Hagoort, P. (2013). MUC (memory, unification, control) and beyond. *Frontiers in psychology, 4*, 416. https://doi: 10.3389/fpsyg.2013.00416

Hamlyn, D. W. (1995). Epistemology, history of. *The Oxford companion to philosophy*, 242-245.

Hammersley, M. (2012). *Methodological paradigms in educational research*. British Educational Research Association.

Hannon, B., & Daneman, M. (2001). A new tool for measuring and understanding individual differences in the component processes of reading comprehension. *Journal of educational psychology, 93*(1), 103. https://doi.org/10.1037/0022-0663.93.1.103

Harmer, J. (2001). The practice of language teaching. *The Practice of English Language Teaching. 3rd ed. Oxford: Longman*, 164-188.

Harrington, M. (2018). The Future of Lexical Facility. In *Lexical Facility* (pp. 261-281). Palgrave Macmillan, London. https://doi.org/10.1057/978-1-137-37262-8_12

Harrington, M., & Sawyer, M. (1992). L2 working memory capacity and L2 reading skill. *Studies in Second Language Acquisition, 14*, 25–38. https://doi.org/10.1017/S0272263100010457

Holderbaum, C. S., & de Salles, J. F. (2011). Semantic priming effects in a lexical decision task: comparing third graders and college students in two different

stimulus onset asynchronies. *The Spanish journal of psychology*, *14*(2), 589-599.

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and writing*, *2*(2), 127-160. https://doi.org/10.1007/BF00401799

Hu, H. M., & Nation, P. (2000). What vocabulary size is needed to read unsimplified texts. *Reading in a Foreign Language, 8*, 689–696.

Hudson, L. A., & Ozanne, J. L. (1988). Alternative ways of seeking knowledge in consumer research. *Journal of consumer research*, *14*(4), 508-521.

Hutchinson, J. M., Whiteley, H. E., Smith, C. D., & Connors, L. (2003). The developmental progression of comprehension-related skills in children learning EAL. *Journal of Research in Reading*, *26*(1), 19-32. https://doi.org/10.1111/1467-9817.261003

Jeon, E. H., & Yamashita, J. (2014). L2 reading comprehension and its correlates: A meta-analysis. *Language Learning, 64*(1), 160–212. https://doi.org/10.1111/lang.12034

Jiang, N. (2012). *Conducting reaction time research in second language studies*. New York, NY: Routledge.

Jiang, X., & Grabe, W. (2011). Skills and strategies in foreign language reading. *La lectura en lengua extranjera*, 2-31.

Jones, J. (2018). How Does Working Memory Training Work? Transfer, Strategies, and Neural Correlates in Children Aged 9-14 Years.

Juffs, A., & Harrington, M. (2011). Aspects of working memory in L2 learning. *Language teaching*, *44*(2), 137.

Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review, 87*(4), 329–354. https://doi.org/10.1037/0033-295X.87.4.329

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological review, 99*, 122–149. https://doi.org/10.1037/0033-295x.99.1.122

Kane, M. J., Hambrick, D. Z., & Conway, A. R. A. (2005). Working memory capacity and fluid intelligence are strongly related constructs: Comment on

Ackerman, Beier, and Boyle (2005). *Psychological Bulletin, 131*, 66–71. https://doi.org/10.1037/0033-2909.131.1.66

Kato, S. (2009). Suppressing inner speech in ESL reading: Implications for developmental changes in second language word recognition processes. *The Modern Language Journal*, *93*(4), 471-488. https://doi.org/10.1111/j.1540-4781.2009.00926.x

Ke, S., & Zhang, D. (in press). Morphological instruction and reading development in young L2 readers: A scoping review of causal relationships.*Studies in Second Language Learning and Teaching*.

Khoii, R., & Sharififar, S. (2013). Memorization versus semantic mapping in L2 vocabulary acquisition. *ELT journal*, *67*(2), 199-209.

Kieffer, M. J., & Lesaux, N. K. (2008). The role of derivational morphology in the reading comprehension of Spanish-speaking English language learners. *Reading and Writing, 21*, 783–804. https://doi.org/10.1007/s11145-007-9092-8

Kintsch, W. (1988). The construction-integration model of text comprehension. *Psychological Review, 95*, 163–182. https://doi.org/10.1037/0033-295X.95.2.163

Kintsch, W., Patel, V. L., & Ericsson, K. A. (1999). The role of long-term working memory in text comprehension. *Psychologia*, *42*(4), 186-198.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. Cambridge, MA: Cambridge University Press.

Kirby, J. R. & Bowers, P. N. (2017). Morphological instruction and literacy: Binding phonological, orthographic, and semantic features of words. In K. Cain, D. L. Compton, & R. K. Parrila (Eds.), *Theories of reading development* (pp. 437–462). Amsterdam: John Benjamins Publishing. https://doi.org/0.1075/swll.15.24kir

Kirk, R. E, (2009) ‘Experimental Design’,in Millsap, R. E., & Maydeu-Olivares, A. (2009). *The SAGE handbook of quantitative methods in psychology*. Sage Publications.pp.23-45. https://dx.doi.org/10.4135/9780857020994

Klauda, S. L., & Guthrie, J. T. (2008). Relationships of three components of reading fluency to reading comprehension. *Journal of Educational psychology*, *100*(2), 310. https://doi.org/10.1037/0022-0663.100.2.310

Koda, K. (1996). L2 word recognition research: A critical review. *The Modern Language Journal*, *80*(4), 450-460. https://doi.org/10.1111/j.1540-4781.1996.tb05465.x

Koda, K. (2000). Cross-linguistic variations in L2 morphological awareness. *Applied Psycholinguistics, 21*, 297–320. https://doi.org/10.1017/S0142716400003015

Koda, K. (2005). *Insights into second language reading: A cross-linguistic approach*. New York, NY: Cambridge University Press.

Koda, K. (2007). Reading and language learning: Crosslinguistic constraints on second language reading development. *Language learning*. https://doi.org/10.1111/j.1467-9922.2007.00411.x

Koda, K., & Yamashita, J. (Eds.). (2018). *Reading to learn in a foreign language: An integrated approach to foreign language instruction and assessment*. Routledge.

Koda, K., Coady, J., & Huckin, T. (1997). Orthographic knowledge in L2 lexical processing. *Second language vocabulary acquisition*, 35-52.

Kremmel, B., Brunfaut, T., & Alderson, J. C. (2017). Exploring the role of phraseological knowledge in foreign language reading. *Applied Linguistics, 38*, 848–870. https://doi.org/10.1093/applin/amv070

Kumar, R. (2014). *Research Methodology: a step-by-step guide for beginners*. (4th ed.). London: SAGE Publication Ltd.

Laufer, B. (1992). How much lexis is necessary for reading comprehension? In P. J. L. Arnaud, & H. Béjoint (Eds.), *Vocabulary and Applied Linguistics* (pp. 129–132). London: Macmillan.

Laufer, B. (1996). The lexical threshold of second language reading comprehension: What it is and how it relates to L1 reading ability. *Approaches to second language acquisition*, 55-62.

Laufer, B., & Nation, P. (2001). Passive vocabulary size and speed of meaning recognition: Are they related?. *Eurosla Yearbook*, *1*(1), 7-28.

Laufer, B., & Ravenhorst-Kalovski, G. C. (2010). Lexical threshold revisited: Lexical text coverage, learners' vocabulary size and reading comprehension. *Reading in a Foreign Language, 22*, 15–30.

Leeser, M. J. (2007). Learner-based factors in L2 reading comprehension and processing grammatical form: Topic familiarity and working memory. *Language learning*, *57*(2), 229-270. https://doi.org/10.1111/j.1467-9922.2007.00408.x

Lervåg, A., & Aukrust, V. G. (2010). Vocabulary knowledge is a critical determinant of the difference in reading comprehension growth between first and second language learners. *Journal of Child Psychology and Psychiatry*, *51*(5), 612-620. https://doi.org/10.1111/j.1469-7610.2009.02185.x

Lesaux, N. K., Lipka, O., & Siegel, L. S. (2006). Investigating cognitive and linguistic abilities that influence the reading comprehension skills of children from diverse linguistic backgrounds. *Reading and Writing, 19*(1), 99-131. https://doi.org/10.1007/s11145-005-4713-6

Li, M., & Kirby, J. R. (2014). Unexpected poor comprehenders among adolescent ESL students. *Scientific Studies of Reading*, *18*(2), 75-93. https://doi.org/10.1080/10888438.2013.775130

Li, M., & Kirby, J. R. (2015). The effects of vocabulary breadth and depth on English reading. *Applied Linguistics, 36*, 611–634. https://doi.org/10.1093/applin/amu007

Louber, I., & Troudi, S. (2019). "Most of the Teaching is in Arabic Anyway", English as a Medium of Instruction in Saudi Arabia, Between De Facto and Official Language Policy. International Journal of Bias, Identity and Diversities in Education (IJBIDE), 4(2), 59-73.

MacGinitie, W., MacGinitie, R., Maria, R. K., & Dreyer, L. G. (*2000*). *Gates-MacGinitie reading tests* (4th ed.). Chicago, IL: Riverside Publishing Co.

Martinez, R., & Murphy, V. A. (2011). Effect of frequency and idiomaticity on second language reading comprehension. *TESOL Quarterly, 45*, 267–290. https://doi.org/10.5054/tq.2011.247708

McNamara, D. S., Graesser, A. C., & Louwerse, M. M. (2012). Sources of text difficulty: Across genres and grades. *Measuring up: Advances in how we assess reading ability*, 89-116.

McNamara, T. P. (2005). Semantic priming: Perspectives from memory and word recognition. New York, NY: Psychology Press.

Meara, P. M. (2009). *Connected words: Word associations and second language vocabulary acquisition*. Amsterdam: John Benjamins Publishing Company.

Melby-Lervåg, M., & Lervåg, A. (2014). Reading comprehension and its underlying components in second-language learners: A meta-analysis of studies comparing first-and second-language learners. *Psychological Bulletin, 140*(2), 409–433. https://doi.org/10.1037/a0033890

Ministry of Education. (2020). Retrieved from https://www.moe.gov.sa/en/Pages/default.aspx

Minzenberg, M. J., Ober, B. A., & Vinogradov, S. (2002). Semantic priming in schizophrenia: a review and synthesis. *Journal of the International Neuropsychological Society: JINS*, *8*(5), 699-720.

Muter, V., Hulme, C., Snowling, M. J., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: evidence from a longitudinal study. *Developmental psychology*, *40*(5), 665. https://doi.org/10.1037/0012-1649.40.5.665

Nagy, W. (2007). Metalinguistic awareness and the vocabulary-comprehension connection. In R. K. Wagner, A. E. Muse, & K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 52–77). New York, NY: The Guilford Press.

Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, 304–330. https://doi.org/10.2307/747823

Nagy, W. E., & Scott, J. A. (2000). Vocabulary processes. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of reading research, Vol. 3* (pp. 269–284). Lawrence Erlbaum Associates.

Nassaji, H. (2003). Higher-level and lower-level text processing skills in advanced ESL reading comprehension. *Modern Language Journal, 87*, 261–276. https://doi.org/10.1111/1540-4781.00189

Nassaji, H. (2014). The role and importance of lower-level processes in second language reading. *Language Teaching, 47*(1), 1–37. https://doi.org/10.1017/S0261444813000396

Nation, I. S. P. (1983). Testing and teaching vocabulary. Guidelines, 5(1), 12–25.

Nation, I. S. P. (1990). Teaching and learning vocabulary. Boston, MA: Heinle & Heinle.

Nation, I. S. P. (2001). *Learning vocabulary in another language*. New York, NY: Cambridge University Press. https://doi.org/10.1017/CBO9781139524759

Nation, K., & Snowling, M. J. (1998). Semantic processing and the development of word-recognition skills: Evidence from children with reading comprehension difficulties. *Journal of Memory and Language, 39*(1), 85–101. https://doi.org/10.1006/jmla.1998.2564

Nation, K., & Snowling, M. J. (2000). Factors influencing syntactic awareness skills in normal readers and poor comprehenders. *Applied psycholinguistics, 21*(2), 229-241.https://doi.org/10.1017/S0142716400002046

Nation, K., & Snowling, M. J. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. *Journal of Research in Reading*, *27*, 342–356. https://doi.org/10.1111/j.1467-9817.2004.00238.x

National Reading Panel (US), National Institute of Child Health, & Human Development (US). (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups*. National Institute of Child Health and Human Development, National Institutes of Health.

Nobre, A. d. P., & Salles, J. F. d. (2016). Lexical-semantic processing and reading: Relations between semantic priming, visual word recognition and reading comprehension. *Educational Psychology, 36*(4), 753-770. https://doi.org/10.1080/01443410.2014.950948

Oakhill, J. (2020). Four decades of research into children's reading comprehension: A personal review. *Discourse Processes, 57*(5-6), 402–419. https://doi.org/10.1080/0163853X.2020.1740875

Oakhill, J. V., & Cain, K. (2012). The precursors of reading ability in young readers: Evidence from a four-year longitudinal study. *Scientific studies of reading*, *16*(2), 91-121. https://doi.org/10.1080/10888438.2010.529219

Oakhill, J., Cain, K., & McCarthy, D. (2015). *Inference processing in children: The contributions of depth and breadth of vocabulary knowledge.* In E. J. O'Brien, A. E. Cook, & R. F. Lorch, Jr. (Eds.), *Inferences during reading* (pp. 140–159). Cambridge University Press.

OH, S. Y. (2001). Two types of input modification and EFL reading comprehension: Simplification versus elaboration. *TESOL quarterly*, *35*(1), 69-96.https://doi.org/10.2307/3587860

Ouellette, G. P. (2006). What's meaning got to do with it: The role of vocabulary in word reading and reading comprehension. *Journal of Educational Psychology, 98*(3), 554–566. https://doi.org/10.1037/0022-0663.98.3.554

Pallant, J. S. P. S. S. (2016). Survival manual: A step by step guide to data analysis using SPSS program.

Pasquarella, A., Gottardo, A., & Grant, A. (2012). Comparing factors related to reading comprehension in adolescents who speak English as a First (L1) or Second (L2) Language. *Scientific Studies of Reading, 16*, 474–503. https://doi.org/10.1080/10888438.2011.593066

Peirce, J. W., Gray, J. R., Simpson, S., MacAskill, M. R., Höchenberger, R., Sogo, H., Kastman, E., Lindeløv, J. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods, 51*, 195–203. https://doi.org/10.3758/s13428-018-01193-y

Perfetti, C. A. (1985). *Reading ability*. Oxford: Oxford University Press.

Perfetti, C. A. (1988). *Verbal efficiency in reading ability.* In M. Daneman, G. E. Mackinnon, & T. G. Waller (Eds.), *Reading research: Advances in theory and practice, Vol. 6* (p. 109–143). Academic Press.

Perfetti, C.A. (1999). Comprehending written language: A blueprint for the reader. In C. Brown & P. Hagoort (Eds.), *Neurocognition of language* (pp. 167–208). Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198507932.003.0006

Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading, 11*, 357–383. https://doi.org/10.1080/10888430701530730

Perfetti, C. A. (2010). Decoding, vocabulary, and comprehension. In M. G. McKeown, & L. Kucan (Eds.), *Bridging reading research to life* (pp. 291–303). New York, NY: The Guilford Press.

Perfetti, C. A., & Adlof, S. M. (2012). Reading comprehension: A conceptual framework from word meaning to text meaning. In J. P. Sabatini, E. R. Albro, & T. O'Reilly (Eds.), *Measuring up: Advances in how we assess reading ability* (pp. 3–20). New York: Rowman & Littlefield Education.

Perfetti, C. A., & Hart, L. (2001). The lexical basis of comprehension skill. In D. S. Gorfein (Ed.), On the consequences of meaning selection: Perspectives on resolving lexical ambiguity (pp. 67–86). Washington, D.C.: American Psychological Association. https://doi.org/10.1037/10459-004

Perfetti, C. A., & Roth, S. (1981). Some of the interactive processes in reading and their role in reading skill. InA. Lesgold & C. Perfetti (Eds.), Interactive processesin reading (pp. 269-297).

Perfetti, C. A., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific studies of Reading*, *18*, 22–37. https://doi.org/10.1080/10888438.2013.827687

Perfetti, C. A., & Stafura, J. Z. (2015). Comprehending implicit meanings in text without making inferences. In E. J. O'Brien, A. E. Cook, & R. F. Lorch, Jr. (Eds.), *Inferences during reading* (pp. 1–18). Cambridge, MA: Cambridge University Press.

Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 227–247). Oxford: Blackwell. https://doi.org/10.1002/9780470757642.ch13

Perfetti, C., Yang, C. L., & Schmalhofer, F. (2008). Comprehension skill and word-to-text integration processes. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition, 22*(3), 303-318. https://doi.org/10.1002/acp.1419

Portal, T. U. (2021). Deanship of Ancillary Studies - English Language Centre.

Pressley, M., & Fingeret, L. (2006). Fluency. *M. Pressley, Reading instruction that works: The case for balanced teaching (3rd ed.). New York: Guilford*.

Proctor, C. P., Silverman, R. D., Harring, J. R., & Montecillo, C. (2012). The role of vocabulary depth in predicting reading comprehension among English monolingual and Spanish–English bilingual children in elementary school. *Reading and Writing, 25*(7), 1635–1664. http://dx.doi.org/10.1007/s11145-011-9351-6

Proctor, C.P., Carlo, M., August, D., & Snow, C. (2005). Native Spanish-speaking children reading in English: Toward a model of comprehension. *Journal of Educational Psychology, 97*, 246–256. https://doi.org/10.1037/0022-0663.97.2.246

Qian, D. D. (1998). *Depth of vocabulary knowledge, assessing its role in adults' reading comprehension in English as a second language* (Doctoral dissertation).

Qian, D. D. (1999). Assessing the roles of depth and breadth of vocabulary knowledge in reading comprehension. *Canadian Modern Language Review, 56*(2), 282–308. https://doi.org/10.3138/cmlr.56.2.282

Qian, D. D. (2002). Investigating the relationship between vocabulary knowledge and academic reading performance: An assessment perspective. *Language Learning, 52*(3), 513–536. https://doi.org/10.1111/1467-9922.00193

Qian, D. D., & Schedl, M. (2004). Evaluation of an in-depth vocabulary knowledge measure for assessing reading performance. *Language Testing, 21*(1), 28–52. https://doi.org/10.1191/0265532204lt273oa

RAND Reading Study Group. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: RAND.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin, 114*, 510–532. https://doi.org/10.1037/0033-2909.114.3.510

Raudszus, H., Segers, E., & Verhoeven, L. (2018). Lexical quality and executive control predict children's first and second language reading comprehension. *Reading and Writing, 31*(2), 405–424. https://doi.org/10.1007/s11145-017-9791-8

Read, J. (1993). The development of a new measure of L2 vocabulary knowledge. *Language Testing, 10*(3), 355–371. https://doi.org/10.1177/026553229301000308

Read, J. (1998). Validating a test to measure depth of vocabulary knowledge. In A. J. Kunnan (Ed.), *Validation in language assessment* (pp. 41–60). Mahwah: Lawrence Erlbaum Associates.

Read, J. (2000). *Assessing vocabulary*. Cambridge, MA: Cambridge University Press.

Read, J. (2004). Plumbing the depths: How should the construct of vocabulary knowledge be defined. In B. Laufer & P. Bogaards (Eds.), *Vocabulary in a second language: Selection, acquisition and testing* (pp. 209–227). Amsterdam: John Benjamins.

Richardson, J. T. E. (2007). Measures of short-term memory: A historical review. *Cortex, 43*, 635–650. https://doi.org/10.1016/S0010-9452(08)70493-3

Richter, T., Isberner, M.-B., Naumann, J., & Neeb, Y. (2013). Lexical quality and reading comprehension in primary school children. *Scientific Studies of Reading, 17*(6), 415–434. https://doi.org/10.1080/10888438.2013.764879

Roth, F. P., Speece, D. L., & Cooper, D. H. (2002). A longitudinal analysis of the connection between oral language and early reading. *Journal of Educational Research, 95*(5), 259–272. https://doi.org/10.1080/00220670209596600

Ruth, M. (2020). Postpositivism. *Salem Press Encyclopedia.*

Sasaki, M. (2000). Effects of cultural schemata on students' test-taking processes for cloze tests: A multiple data source approach. *Language testing*, *17*(1), 85-114.

Sasao, Y., & Webb, S. A., & (2017). The Words Parts Levels Test. *Language Teaching Research, 21*, 12–30. https://doi.org/10.1177/1362168815586083

Saunders, M. N., & Lewis, P. (2012). *Doing research in business & management: An essential guide to planning your project*. Pearson.

Saunders, M., Lewis, P. & Thornhill, A. (2012). Research Methods for Business Students. 6th edition, Pearson Education Limited.

Schmitt, N. (2014). Size and depth of vocabulary knowledge: What the research shows. *Language Learning, 64*(4), 913–951. https://doi.org/10.1111/lang.12077

Schmitt, N., Jiang, X., & Grabe, W. (2011). The percentage of words known in a text and reading comprehension. *The Modern Language Journal, 95*, 26–43. https://doi.org/10.1111/j.1540-4781.2011.01146.x

Schmitt, N., Ng, J. W. C., & Garras, J. (2011). The word associates format: Validation evidence. *Language Testing*, *28*(1), 105-126. https://doi.org/10.1177/0265532210373605

Schmitt, N., Schmitt, D., & Clapham, C. (2001). Developing and exploring the behaviour of two new versions of the Vocabulary Levels Test. *Language Testing, 18*(1), 55–88. https://doi.org/10.1177/026553220101800103

Schoonen, R., & Verhallen, M. (2008). The assessment of deep word knowledge in young first and second language learners. *Language Testing, 25*(2), 211-236. https://doi.org/10.1177/0265532207086782

Schrag, F. (1992). In defense of positivist research paradigms. *Educational researcher*, *21*(5), 5-8.

Schwandt, T. A. (1997). *Qualitative inquiry: A dictionary of terms*. Sage Publications, Inc.

Segalowitz, N., & Hulstijn, J. (2005). Automaticity in bilingualism and second language learning. *Handbook of bilingualism: Psycholinguistic approaches*, *371*, 388.

Segers*, E., &* Verhoeven*, L. (*2016*).* How logical reasoning mediates the relation between lexical quality and reading comprehension. *Reading and Writing, 29*, 577–590. https://doi.org/10.1007/s11145-015-9613-9

Seidenberg, M. S. (2005). Connectionist models of word reading. *Current directions in psychological science*, *14*(5), 238-242.

Shin, J. (2020). A meta-analysis of the relationship between working memory and second language reading comprehension: Does task type matter?. *Applied Psycholinguistics*, *41*(4), 873-900.

Shin, J., Dronjic, V., & Park, B. (2019). The interplay between working memory and background knowledge in L2 reading comprehension. *TESOL Quarterly, 53*(2), 320–347. https://doi.org/10.1002/tesq.482

Shiotsu, T. (2010). *Components of L2 reading: Linguistic and processing factors in the reading test performances of Japanese EFL learners*. Cambridge: Cambridge University Press.

Shiotsu, T., & Weir, C. J. (2007). The relative significance of syntactic knowledge and vocabulary breadth in the prediction of reading comprehension test performance. *Language Testing, 24*(1), 99–128. https://doi.org/10.1177/0265532207071513

Singer, M., & Ritchot, K. F. (1996). The role of working memory capacity and knowledge access in text inference processing. *Memory & cognition*, *24*(6), 733-743. https://doi.org/10.3758/BF03201098

Snowling, M. J., & Hulme, C. E. (2005). *The science of reading: A handbook*. Blackwell Publishing.

Spätgens*, T. &* Schoonen*, R. (2018*). The semantic network, lexical access and reading comprehension in monolingual and bilingual children: An individual differences study. *Applied Psycholinguistics, 39*(1), 225–256. https://doi.org/10.1017/S0142716417000224

Stæhr, L. S. (2008). Vocabulary size and the skills of listening, reading and writing. *Language Learning Journal*, *36*(2), 139-152. https://doi.org/10.1080/09571730802389975

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading research quarterly*, 32-71. https://doi: 10.2307/747348

Stanovich, K. E. (2000). *Progress in understanding reading: Scientific foundations and new frontiers*. Guilford Press.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273-1296.

Taguchi, E., Gorsuch, G. J., & Sasamoto, E. (2006). Developing second and foreign language reading fluency and its effect on comprehension: A missing link. *Reading Matrix: An International Online Journal*, *6*(2).

Taguchi, E., Takayasu-Maass, M., & Gorsuch, G. J. (2004). Developing Reading Fluency in EFL: How Assisted Repeated Reading and Extensive Reading Affect Fluency Development. *Reading in a foreign language*, *16*(2), 70-96.

Tannenbaum, K. R., Torgesen, J. K., & Wagner, R. K. (2006). Relationships between word knowledge and reading comprehension in third-grade children. *Scientific Studies of Reading, 10*(4), 381–398. https://doi.org/10.1207/s1532799xssr1004_3

Tokowicz, N. (2014). *Lexical processing and second language acquisition*. New York, NY: Routledge.

Townsend, J. T., & Ashby, F. G. (1983). *Stochastic modeling of elementary psychological processes*. Cambridge: Cambridge University Press. uploads/2018/06/BERA-Ethical-Guidelines-for-Educational-Research_4thEdn_2018.pdf?noredirect=1s

Urquhart, A. H., & Weir, C. J. (1998). *Reading in a second language: Process, product and practice*. London: Longman.

Van Dijk, T. A., & Kintsch, W. (1983). Strategies of discourse comprehension.

Van Gelderen, A., Schoonen, R., De Glopper, K., Hulstijn, J., Simis, A., Snellings, P., & Stevenson, M. (2004). Linguistic knowledge, processing speed, and metacognitive knowledge in First-and Second-Language reading comprehension: A componential analysis. *Journal of educational psychology, 96*, 19–30. https://doi.org/10.1037/0022-0663.96.1.19

Walter, C. (2004). Transfer of reading comprehension skills to L2 is linked to mental representations of text and to L2 working memory. *Applied linguistics*, *25*(3), 315-339. https://doi.org/10.1093/applin/25.3.315

Webb, S. A., & Sasao, Y. (2013). New directions in vocabulary testing. *RELC Journal, 44*(3), 263-277. https://doi.org/10.1177/0033688213500582

Willows, D. M., & Ryan, E. B. (1986). The development of grammatical sensitivity and its relationship to early reading achievement. *Reading Research Quarterly*, 253-266.

Woltz, D. J. (2003). Implicit cognitive processes as aptitudes for learning. *Educational Psychologist*, *38*(2), 95-104. https://doi.org/10.1207/S15326985EP3802_4

Wright, T. S., & Cervetti, G. N. (2017). A systematic review of the research on vocabulary instruction that impacts text comprehension. *Reading Research Quarterly*, *52*(2), 203-226. https://doi.org/10.1002/rrq.163

Wurr, A. J. (2003). Reading in a second language: A reading problem or a language problem?.*Journal of college reading and learning*, *33*(2), 157-169.

Yamashita, J. (2013). Word recognition subcomponents and passage level reading in a foreign language. *Reading in a Foreign Language, 25*, 52–71.

Yamashita, J., & Shiotsu, T. (2017). Comprehension and knowledge components that predict L2 reading: A latent-trait approach. *Applied linguistics*, *38*(1), 43-67.

Yang, C. L., Perfetti, C. A., & Schmalhofer, F. (2005). Less skilled comprehenders' ERPs show sluggish word-to-text integration processes. *Written Language & Literacy, 8*(2), 157-181. https://doi.org/10.1075/wll.8.2.10yan

Yang, C. L., Perfetti, C. A., & Schmalhofer, F. (2007). Event-related potential indicators of text integration across sentence boundaries. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(1), 55–89. https://doi.org/10.1037/0278-7393.33.1.55

Zarić, J., Hasselhorn, M., & Nagler, T. (2020). Orthographic knowledge predicts reading and spelling skills over and above general intelligence and phonological awareness. *European Journal of Psychology of Education*, 1-23.

Zhang, D. (2012). Vocabulary and grammar knowledge in second language reading comprehension: A structural equation modeling study. *The Modern Language Journal, 96*(4), 558–575. https://doi.org/10.1111/j.1540-4781.2012.01398.x

Zhang, D. (2017). Derivational morphology in reading comprehension of Chinese-speaking learners of English. *Applied Linguistics, 38*, 871–895. DOI:10.1093/applin/amv072

Zhang, D., & Ke, S. (2020). The simple view of reading made complex by morphological decoding fluency in bilingual fourth-grade readers of English. *Reading Research Quarterly*. https://doi.org/10.1002/rrq.287

Zhang, D., & Koda, K. (2012). Contribution of morphological awareness and lexical inferencing ability to L2 vocabulary knowledge and reading

comprehension among advanced EFL learners: Testing direct and indirect effects. *Reading and Writing, 25*, 1195–1216. https://doi.org/10.1007/s11145-011-9313-z

Zhang, D., & Koda, K. (2013). Morphological awareness and reading comprehension in a foreign language: A study of young Chinese EFL learners. *System, 41*, 901–913. http://doi.org/10.1016/j.system.2013.09.009

Zhang, D., & Koda, K. (2017). Assessing L2 learners' vocabulary depth with Word Associates Format tests: Issues, findings, and suggestions. *Asian-Pacific Journal of Second and Foreign Language Education, 2*(1). https://doi.org/10.1186/s40862-017-0024-0

Zhang, D., & Yang, X. (2016). Chinese L2 learners' depth of vocabulary knowledge and its role in reading comprehension. *Foreign Language Annals, 49*(4), 699–715. http://doi.org/10.1111/flan.12225

Zhang, J., Lin, T. J., Wei, J., & Anderson, R. C. (2014). Morphological awareness and learning to read Chinese and English. In *Reading development and difficulties in monolingual and bilingual Chinese children* (pp. 3-22). Springer, Dordrecht.

Zhang, S., & Zhang, X. (2020). The relationship between vocabulary knowledge and L2 reading/listening comprehension: A meta-analysis. *Language Teaching Research*. https://doi.org/10.1177/1362168820913998

Zhang, X., & Lu, X. (2014). A longitudinal study of receptive vocabulary breadth knowledge growth and vocabulary fluency development. *Applied Linguistics*, *35*(3), 283-304. https://doi.org/10.1093/applin/amt014

Zwaan, R. A., & Rapp, D. N. (2006). Discourse comprehension. In M. A. Gernsbacher & M. J. Traxler (Eds.), *Handbook of psycholinguistics* (pp. 725–764). San Diego, CA: Elsevier. https://doi.org/10.1016/B978-012369374-7/50019-5

Appendix (1)

Ethical form

COLLEGE OF SOCIAL SCIENCES AND INTERNATIONAL STUDIES

Applicant details		
Name	Mona Ghurman Alshehri	
Department	Education	
UoE email address	Ma589@exeter.ac.uk	
Duration for which permission is required		
Start date:06/01/201906/01/2019	**End date:**16/06/202016/06/2020	**Date Submitted:**16/10/201816/10/2018
Students only		
Student number	660014109	
Program of study	Doctor of Philosophy (PhD)Doctor of Philosophy (PhD)	
Name of Supervisor(s) or Dissertation Tutor	Professor Dongbo Zhang, Dr. Chris Boyle	
Have you attended any ethics training that is available to students?	Yes, I have taken part in ethics training at the University of ExeterYes, I have taken part in ethics training at the University of Exeter In one of the modules of the MSc of Educational Research course, I had to complete a mini-research project which required submitting an ethical form. Before that, I had completed an obligatory online course about educational research ethics, followed by studying some questions on ELE as one of the requirements of the modules. This was besides attending the following workshop on ethical considerations of research. The Research Integrity Ethics and Governance workshop: http://as.exeter.ac.uk/rdp/postgraduateresearchers	

	I have also read the Ethical Guidelines of the British Educational Research Association (2018) and will ensure this study is fully compliant with the specifications there.

Certification for all submissions

I hereby certify that I will abide by the details given in this application and that I undertake in my research to respect the dignity and privacy of those participating in this research. I confirm that if my research should change significantly, I will seek advice, request approval of an amendment, or complete a new ethics proposal. Any document translations used have been provided by a competent person with no significant changes to the original meaning.

Mona Alshehri

Double click this box to confirm certification ☒

TITLE OF YOUR PROJECT

Contribution of different dimensions of word knowledge to reading comprehension in English as a Foreign language

ETHICAL REVIEW BY AN EXTERNAL COMMITTEE

No, my research is not funded by, or doesn't use data from, either the NHS or Ministry of Defence.No, my research is not funded by, or doesn't use data from, either the NHS or Ministry of Defence.

MENTAL CAPACITY ACT

No, my project does not involve participants aged 16 or over who are unable to give informed consent (e.g. people with learning disabilitiesNo, my project does not involve participants aged 16 or over who are unable to give informed consent (e.g. people with learning disabilities).

SYNOPSIS OF THE RESEARCH PROJECT

The current study aims to investigate how the level of different dimensions of knowledge about words (sub-word level, word-level, and beyond word level) and the speed of access to that knowledge contribute to reading comprehension in adult learners of English as a foreign language in Saudi Arabia and how the pattern

of predictive relationships may differ between different levels of comprehension (i.e., literal and inferential).

Specifically, this study intends to answer the following two primary research questions:

1. How do several dimensions of word knowledge, at the sub-word, word, and beyond word levels and including both availability (i.e., knowledge) and accessibility (i.e., the efficiency of accessing that knowledge), contribute to reading comprehension in Arabic-speaking adult learners of English as a foreign language?
2. How may the pattern of predictive relationships differ between different levels of comprehension (literal vs. inferential)?

To answer the study's questions group- and individual-based tests that assess some cognitive, vocabulary, grammar, and reading comprehension abilities will be conducted using paper- and computer-based tests. This will be done through two phases.

The first one is a pilot study which will include about 30 participants who learn English as a foreign language (EFL) in a Saudi university (Taif university), and it will take about two weeks to be completed. In addition to the quantitative analysis for refining the instruments, informal chat with 3-5 of the participants will be conducted to get their thoughts on the instruments. This phase is essential to refine the instruments and to assess their validity and reliability. The second phase will be the data collection of the study and its participants will be about 200 first-year university students who also learn English as a foreign language in the same Saudi university.

The study will involve both paper-based and computer-based testing of reading and its related abilities. Paper-based testing will be administered on a group basis. It will be divided into several sessions based on the participants' and their classes' convenience with each session about 20-30 minutes as a whole group during their classes. On the other hand, the computer-based testing will be administered to EFL learners individually outside of their classes in one session that will last for about 40-60 minutes. The completion of all test sessions should take no longer than 3 hours from the participants over a period of 4-6 weeks.

Prof. Dongbo Zhang,

Dr. Christopher Boyle

INTERNATIONAL RESEARCH

This research will be conducted in a Saudi university, i.e., Taif University, which is also my sponsor for the doctoral study at the University of Exeter. The ethical procedure of data collection from students in Saudi educational institutions imposes asking for permission to access the study's participants, but no additional local ethics review is needed. Thus, a request must be sent to the research office at Taif university for permission to conduct my study attached with a detailed description of the study and its instruments. The required documents have been sent, and permission has already been obtained by the researcher.

In addition, as a sponsored student I must apply for 'a scientific trip' before traveling back to Saudi or to any place to collect any data for my research. The requirements of the scientific trip are the permission letter that was obtained from the educational institution where I am going to conduct my research and a letter from my supervisor at the University of Exeter explaining the need for this trip. Both letters have been obtained and submitted to the Saudi Cultural Bureau in the UK with my request for the scientific trip.

The Bureau has then, on my behalf, contacted my sponsor in Saudi Arabia, Taif University, to approve the request. After the approval was attained for the scientific trip, I can travel back to Saudi to collect data. Moreover, I must present the permission letter to the department administrator of Taif University (the site of the proposed study) to be then allowed to contact language teachers and liaise with them for me to be in their classes and for subsequent data collection activities.

RESEARCH METHODS

To answer the study's questions, a test battery will be administered to the participants to assess some cognitive, vocabulary, grammar, and reading comprehension abilities. In addition, a questionnaire inquiring about the participants' English language learning background will be administrated, which will be administered first and require no more than ten minutes to be completed.

The following paper- or computer-based measurement tasks will be administered. The paper-based tests will be administrated to the participants in their regular English classes and be invigilated by the researcher with appropriate arrangements with teachers. The required time to complete these tests will vary due to individual differences in the participants; however, the average time is estimated to be about two hours in total. The paper-based group testing will be divided into four sessions of 30 minutes or six sessions of 20 minutes based on the participants' and their classes' convenience over a period of four to six weeks. On the other hand, the computer-based tests will be administrated to the same participants individually in one session measuring their reaction time to some tasks described below. This individual testing will last about 40 minutes and will be divided into a few sessions with short breaks between tasks.

Paper-based group testing

1. Reading Comprehension. It will be paper-based including passages and followed by comprehension questions. These questions will be either multiple choice questions or short answer questions.
2. Vocabulary knowledge. It will be paper-based including several sections that assess different aspects of vocabulary knowledge. The questions in this section will be mainly multiple choices and matching.
3. Grammatical knowledge. It will be paper-based including error identification and correction for some sentences.

Individual, computer-based testing

4. Lexical processing. It will be computer-based including several sections of different aspects. It will include several decision tasks on the computer (pressing yes/no), and the accuracy and reaction time of responses will be recorded by the computer.
5. Grammatical processing. This section will be grammaticality judgment of short sentences (grammatically correct or ill-formed). This decision task will be on the computer (pressing yes/no to indicate judgment of grammaticality), and the accuracy and reaction time of responses will be recorded by the computer.

6. Working memory. It will be measured using a word span task in the Arabic language, which is the native language of the participants. For each item, a small number of short sentences will be presented, and the participant will have to remember the last word in each sentence and name those words following their order of appearance. The words named and the reaction time will be recorded by the computer.

The test results will be analysed using various multivariate statistical analysis methods; and findings will be reported as a whole group rather than on an individual basis.

PARTICIPANTS

The target population of the study is first-year university students who learn English as a foreign language in Saudi Arabia. The participants will be about 200 first-year students at Taif University. The normal age range of first-year students studying at university in Saudi is between 17 and 25 years old, with rare cases of students who are older than 25. The legal age in Saudi is 18, thus, students who are less than 18 years old will be excluded from participation. The participants will represent a range of undergraduate majors offered at Taif University, for example, medical, humanities, science, and business majors.

To recruit the participants, I will first contact the English teachers to allow me to be in their classes explaining to EFL students my study and their role. I will also provide them with copies of the information sheets and consent forms if they agree to participate. This will be followed by a short questionnaire about their English language learning. Then, I will liaise with the teachers to find a suitable class time to conduct the paper-based tests over a period of 4-6 weeks. Regarding the individual testing session, I will ask the teachers to help with the signup process using the university website. I will make a daily schedule to meet the students and they will have access to editing the date and the time to sign up for individual test sessions. Although help from teachers is to be obtained, I will indicate clearly in the information sheet for participants that their participation is completely voluntary and whether or not they opt to participate, and their performance on the tests

should they choose to participate, will have no bearing on their academic standing in the English courses they are taking.

THE VOLUNTARY NATURE OF PARTICIPATION

The participants will voluntarily participate in this project. They will be explained that no research incentive or reward will be offered for their participation. Although the study will be arranged through their English teacher, whether they will participate will no bearing on their academic standing in the course.

SPECIAL ARRANGEMENTS

There are no special arrangements such as providing documents in a large font or providing the extra time required for this project. However, the individual computer-based testing will require a quiet place on the Taif university campus. This will be arranged with help from the administration of Taif University.

THE INFORMED NATURE OF PARTICIPATION

The department administrator of Taif University, where the data will be collected, will help me to contact English language teachers at Taif University and I will use my connection as a former lecturer in the same university to contact individual teachers requesting their permission to access their classes. Then, I will visit their classes to verbally explain the project to the students. They will know what the project is about and what risks or benefits of participating might be. This will be facilitated by distributing copies of the information sheet enclosed in this application, which provides a full explanation of the research and participants' role. Students will be asked to read the information sheet and consider it carefully before they decide to participate by signing the consent form. Both the information sheet and the consent form will be provided in their native language (Arabic) to assure their understanding. The forms were translated by me, a fluent Arabic-English bilingual proficient in Arabic and English literacy, and then it was checked by another competent person with no significant changes to the original meaning. In addition, the participants will be informed that their autonomy will be respected by providing them with the chance to decide whether they want to contribute to the

research and whether they want to complete all the research measures or not. They will also be anonymized using their university ID numbers so that they will not be traceable or recognizable in any way to protect their privacy.

The first instrument, that is, the questionnaire, will be administrated right after the participants sign their consent form. However, the paper-based tests sessions will be conducted later after the appropriate arrangement has been made with their English teacher, while the computer-based session will be arranged by publishing an appointment booking on the course site that is part of the university site and to which all the students easily have access. The first 30 participants will be a pilot study and they will be informed about that and their responses will be used to refine the instruments and to measure their validity and reliability. There will be two different sets of consent form and information sheet: one for the participants who will participate in the pilot study and the other for the participants of the study.

ASSESSMENT OF POSSIBLE HARM

I do not believe that there is any possible psychological, legal, political, financial or physical harm either to the participants or to the researcher. Given the time needed from each participant to answer test questions could be long, the testing will be divided to different sessions based on the participants' and their classes' convenience. The total of time is about three hours. Two hours will be the total time of paper-based testing in a whole class format. It will be divided to about 4 sessions of 30 minutes each or 6 sessions of 20 minutes each in 4-6 weeks based on their classes' time with arrangement with their teachers. Another hour is needed for a computer-based, individual testing session, which will be divided into several sub-sessions, with short breaks between tasks.

I also assume that there is no possible harm to myself. I am a citizen of Saudi, having worked in the same university where I am going to collect the data, and the data collection will receive help from my colleagues. In addition, the study will be conducted on Taif University's campus, which is a convenient and safe place for me and for the participants.

DATA PROTECTION AND STORAGE

To protect data some procedures will be taken. To keep anonymity and privacy, students' names will not be recorded; instead, their university ID will be used. Consent forms with participants' signatures will be scanned with the digital copies stored in my University of Exeter's secure OneDrive and then shredded and disposed of in a safe way in Saudi before I travel back to the UK. This will be similarly done for the questionnaire and test papers after participants' responses were digitized in SPSS and uploaded to OneDrive. Students' responses to computer-based tests will also be uploaded to OneDrive and then deleted from my personal computer. Data analysis will be conducted at the group level and results reported on the participants as a whole group without referring to any individual students.

DECLARATION OF INTERESTS

Although this project is conducted for me to earn my PhD degree, I am a sponsored student with the PhD study supported by the Saudi government. Thus, it will be published in Saudi academic websites as a requirement of the sponsorship. The outcomes of the project will be made available at the end of the project on websites such as, but not exclusively, the Saudi digital library (SDL) as a requirement of the Saudi government which funds my PhD study.

USER ENGAGEMENT AND FEEDBACK

The participants' performance on the tests will not be shared with them. Their engagement and feedback are not required in this study.

INFORMATION SHEET

Two sets of information sheet (and consent form) are enclosed in this application: one for the participants of the pilot study and the other is for the participants of the main study. They will be presented to the participants in their native language (Arabic) to assure their understanding. The Arabic versions were translated by the researcher herself, who is a fluent Arabic-English bilingual

proficient in literacy in both languages; the translation was also checked by another competent person with back translation from Arabic to English and vice versa to ensure that there are no significant changes to the original meaning. The information sheet will be distributed to the potential participants in their classes along with a verbal explanation of each section in the information sheet from the researcher. The information sheet contains the research title, an invitation to participate including the research information, the participant's rights, the participant's role, etc. Participants will be given some time to read the information sheet and consider it carefully it with a chance to have any questions clarified before they sign the consent form.

(see the information sheet for additional information).

CONSENT FORM

A written consent form is also enclosed in this application. It will be obtained individually from each participant. It will cover the following: a) confidentiality, b) anonymity c) information about the project, and d) the right to withdraw at any time without disadvantage to the participant. It starts with the research title, and the researcher's name then they will be asked to provide their initial next to some sentences. These sentences will be about that confidentiality and anonymity of the participants information will be maintained. In addition, the participants' rights to withdraw at any time without disadvantage to them, besides the related information of the way that the data will be used will be clearly mentioned. At the end of the consent form, they will be asked to write their names and sign. An Arabic version of the consent form will be given to the potential participants as they may not be adequately proficient in English. The same procedure was taken like that for the information sheet to ensure the Arabic translation shows no significant changes to the original meaning. Students will also be given time to carefully read the consent form before they sign two copies of the form: one copy will be kept by the participant and the other copy by me the researcher. (see the consent form for additional information).

Appendix (2)

Certificate of Ethical Approval from University of Exeter

UNIVERSITY OF EXETER

GRADUATE SCHOOL OF EDUCATION

St Luke's Campus
Heavitree Road
Exeter UK EX1 2LU

http://socialsciences.exeter.ac.uk/education/

CERTIFICATE OF ETHICAL APPROVAL

Title of Project: Contribution of different dimensions of word knowledge to reading comprehension in English as a Foreign language

Researcher(s) name: Mona Ghurman Alshehri

Supervisor(s): Professor Dongbo Zhang
Dr. Chris Boyle

This project has been approved for the period

From: 06/01/2019
To: 16/06/2020

Ethics Committee approval reference: D1819-022

Signature: Justin Dillon Date: 07/01/2019
(Professor Justin Dillon, Professor of Science and Environmental Education, Ethics Officer)

Appendix (3)

Data Collection Permission from Taif University

وكيلة الجامعة
لشؤون الطالبات

جامعة الطائف
TAIF UNIVERSITY

رؤية 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

تعميم

سعادة عميدة ..... **سلمها الله**

سعادة وكيلة ..... **سلمها الله**

السلام عليكم ورحمة الله وبركاته

مُرفق لسعادتكم الخطاب الوارد إلينا من سعادة وكيل الجامعة للدراسات العليا والبحث العلمي رقم (١٢٣٨٣) وتاريخ ١٤٤٠/٢/٢١هـ بخصوص طلب الباحثة المحاضرة /منى غرمان الشهري بالكلية الجامعية بتربة (قسم العلوم التربوية) لمشروع البحث والذي بعنوان "دور الأبعاد المختلفة للمعرفة اللغوية للمفردة في الفهم القرائي للغة الإنجليزية كلغة أجنبية" وسيتم تطبيق دراسة البحث خلال الفصل الدراسي الثاني للعام الأكاديمي ١٤٤٠/١٤٤١هـ وبالتحديد على طالبات المستوى الثاني بجامعة الطائف في مختلف التخصصات.

عليه، نأمل من سعادتكم تسهيل مهمة الباحثة في تطبيق أداة الدراسة الخاصة بالبحث .

للإطلاع واتخاذ اللازم.

ولكم جزيل الشكر والتقدير

وكيلة الجامعة لشؤون الطالبات

د. إيمان بنت سعد الزهراني

الرقم: ١٥٠٤٤
التاريخ: ١٤٤٠/٢/٢٢هـ
المرفقات:
الموضوع:

www.tu.edu.sa

المملكة العربية السعودية - وزارة التعليم
الطائف - الحوية - ص.ب ٨٨٨ الرمز البريدي ٢١٩٧٤
هاتف ٠١٢٧٢٧٢٠٠ - فاكس ٠١٢٧٢٧٤٢٩٩

Appendix (4)

Information Sheets and Consent Forms

Participant Information Sheet

Title of Project: Contribution of different dimensions of word knowledge to reading comprehension in English as a foreign language

Researcher name: Mona Alshehri

Dear student,

My name is Mona Alshehri, a PhD student at the University of Exeter, England. I am conducting this research study as part of my PhD thesis project, which aims to examine how various types of word knowledge are important for university students' reading comprehension in English. To this end, I will conduct group and individual tests that assess some cognitive, vocabulary, grammar and reading comprehension abilities using paper and computer-based tests. Testing will be divided into several sessions; the tests will be administered to you individually outside of your class or as a whole group based on your convenience. The completion of all test sessions should take no longer than 3 hours in 4-6 sessions. The answers that you will provide to the tests are considered research data and will be analysed and reported as a whole group using statistical analysis rather than on an individual basis. I would therefore be very grateful if you would take the time and trouble to complete these tests.

To ensure complete anonymity, your personal identification is not required; however, you will be asked to provide your university student ID, and it is important that the responses you provide are your own and not the shared views of other colleagues. Please take time to consider the information carefully. I would like to emphasise that participation is entirely voluntary and that I am more than happy to answer any queries at the email address: Ma589@ exter.ac.uk; or, you may contact my supervisor Professor Dongbo Zhang at d.zhang@exeter.ac.uk.

Many thanks,

Mona Alshehri

Purpose of the research:

The aim of this study is to investigate how university students' knowledge about English words is important for their English reading comprehension. A battery of paper- and computer-based tests will be administered to students individually or as a whole class. Their scores on the tests will be analysed through statistical analysis on a group basis to reveal the pattern of association of various types of word knowledge with English reading comprehension.

Why have I been approached?

The focus of this study is on English as a Foreign Language (EFL) learners in Saudi public universities. You have been approached because you are a university-level EFL learner.

What would taking part involve?

If you opt to take part in this study, you will be asked to answer a questionnaire which is mainly about your English language learning background. It will need no more than 10 minutes to be completed. In addition, you will be assessed with some paper- and computer-based tasks on your cognitive, vocabulary, grammar and reading comprehension abilities. The paper-based tests, mostly multiple-choices, will be administered to you in several sessions on a group basis in a quiet classroom with other participants based on appropriate arrangement with your English teacher and you. The computer-based tests will be conducted fact-to-face with me at a quiet place on your university campus and at your convenience in one session which will last 40-60 minutes. For those tests, your response accuracy and speed of the responses will both be recorded on a computer. All the tests will be administered in a window of 4-6 weeks; altogether your participation will be no more than three hours.

What are the possible benefits of taking part?

Although your participation will not bring immediate, direct effects on your English learning, you will have an opportunity to increase your awareness that various types of word knowledge, including how the speed of accessing them, are important in your reading comprehension development. This awareness may help with your English vocabulary learning in the long run.

In addition, this study will deliver wider benefits, theoretically, the results of this study will contribute to the knowledge of word knowledge dimensions and reading comprehension of L2 learning and inform the construction of a more accurate reading comprehension model for L2 readers. It also can provide practical guidance for curricular design and instruction better to address L2 learners' developmental needs in reading comprehension. Pedagogically, this study could explain to L2 educators which type of knowledge and which components of a knowledge is more important to L2 reading comprehension and, thus, deserve more attention in L2 reading pedagogy.

What are the possible disadvantages and risks of taking part?

I do not believe that taking part in the research has any foreseeable risks or disadvantage to you.

What will happen if I don't want to carry on with the study?

You can stop taking part or withdraw from the study at any time without having to give a reason. Whether or not you take part in this study or discontinue your participation at any time later will not have any bearing on your academic standing in the English course you are taking.

How will my information be kept confidential?

The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University will endeavour to be transparent about its processing of your personal data and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing

dataprotection@exeter.ac.uk

or at

www.exeter.ac.uk/dataprotection

Taking part involves anonymised responses to be used for the purposes of inclusion in an archive for a period of up to 5 years, shared with other researchers for use in future research projects, reports published in an academic publication, and teaching or training materials for use in University activities. Participants' data

processed for any purpose or purposes will not be kept for longer than is necessary for that purpose or those purposes.

To protect data some procedures will be taken. To keep anonymity and privacy, students' names will not be recorded; instead, their university ID will be used. Consent forms with participants' signatures will be scanned with the digital copies stored in my University of Exeter's secure OneDrive and then shredded and disposed of in a safe way in Saudi before I travel back to the UK. This will be similarly done for the questionnaire and test papers after participants' responses were digitized in SPSS and uploaded to OneDrive. Students' responses to computer-based tests will also be uploaded to OneDrive and then deleted from my personal computer. Data analysis will be conducted at the group level and results reported on the participants as a whole group without referring to any individual students.

Will I receive any payment for taking part?

Participation in the study is completely voluntary. You will not receive any payment for taking part in this study.

What will happen to the results of this study?

The results of the research will be published in academic publications, conferences and teaching or training materials for use in University activities. The outcomes of the project will be made available at the end of the project on websites such as, but not exclusively, the Saudi digital library (SDL) as a requirement of the Saudi government, which funds my PhD study.

Who is organizing and funding this study?

This study is funded by Taif University as I am a sponsored student studying in the UK.

Who has reviewed this study?

This project has been reviewed by the Research Ethics Committee of the Graduate School of Education, College of Social Sciences and International Studies at the University of Exeter (D1819-022).

Further information and contact details

For further information about this study or your participation, please contact me at ma589@exeter.ac.uk or my supervisor Professor Dongbo Zhang at d.zhang4@exeter.ac.uk.

If you are not happy with any aspect of the project and wish to complain please contact the Ethics Committee of the College of Social Sciences and International Studies at

ssis-ethics@exeter.ac.uk

Thank you for your interest in this project,

Mona Alshehri

Consent Form

Title of Project: Contribution of different dimensions of word knowledge to reading comprehension in English as a Foreign language

Name of Researcher: Mona Ghurman Alshehri

Participant Identification Number: ……

Please initial box

- I confirm that I have read the information sheet dated..... (version no.....) for the above project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my legal rights being affected.
- I understand that relevant sections of the data collected during the study, may be looked at by members of the research team, individuals from the University of Exeter, Taif University, where it is relevant to my taking part in this research.
- I give permission for these individuals to have access to my records.
- I understand that taking part involves anonymised tests' answers to be used for the purposes of the research.

[shared with other researchers for use in future research projects]

[reports published in an academic publication, project website, media publication]

[teaching or training materials for use in University activities, public engagement activities]

- I agree to take part in the above project.

Name of Participant	Date	Signature
Name of researcher taking consent	Date	Signature

When completed: 1 copy for participant; 1 copy for researcher/project file

Appendix (5)

English language learning questionnaire (English language version)

Student ID number: _____

<table>
<tr><td colspan="4">Please answer the following questions to the best of your knowledge about your English language learning background?</td></tr>
<tr><td colspan="4">• Age: _____</td></tr>
<tr><td colspan="4">• Major: _____</td></tr>
<tr><td colspan="4">• Years or months of residence in a country where English language is spoken. And what is this country? _____</td></tr>
<tr><td colspan="4">• Age at which English language learning started: _____ or grade: _____</td></tr>
<tr><td colspan="4">• How did you learn your English language up to this point? (check all that apply)
Mainly through formal classroom instruction _____
Mainly through interacting with people _____
A mixture of both _____
Other (specify)_____</td></tr>
<tr><td colspan="4">• How much time do you spend learning English per week?</td></tr>
<tr><td>a- Less than 6 hours</td><td>b-from 6 to 7 hours</td><td>c- from 7 to 8 hours</td><td>d- More than 8 hours</td></tr>
<tr><td colspan="4">• How much time do you spend reading in English per week?</td></tr>
<tr><td>a- Less than 6 hours</td><td>b-from 6 to 7 hours</td><td>c- from 7 to 8 hours</td><td>d- More than 8 hours</td></tr>
</table>

• How would you assess your reading comprehension of English on a scale from 1-5 considering 5 the highest one?				
a. 1	b. 2	c. 3	d. 4	e. 5
• How would you assess your motivation to read in English on a scale from 1-5 considering 5 as the highest one?				
a. 1	b. 2	c. 3	d. 4	e. 5
• What is your main reading in English?				
a. Course books	b. Books other than course books	c. Newspaper and magazines	d. Social media apps	

Appendix (6)

Lexical Knowledge Measure

الرقم الجامعي: _____

هذا الاختبار يتكون من أربعة أقسام و كل قسم يمثل مستوى مختلف من المفردات الأكثر استخداماً في اللغة الإنجليزية (1000، 2000،3000، 5000) و كل مستوى يتكون من ست مجموعات، علماً بأنك لن تستغرقي أكثر من 20 دقيقة لإكمال هذا الاختبار:

اكتبي رقم المفردة الإنجليزية من العمود الأيسر بجوار احدى المعاني الثلاثة المقدمة بالعمود الأيمن علماً بأن هناك ستة مفردات في كل فقرة و ثلاثة معاني فقط:			
1000 level 1)			
1.	choice	_____	cost (سعر)
2.	computer	_____	picture (صورة)
3.	garden	_____	place where things grow outside (مكان مفتوح تنمو به النباتات)
4.	photograph		
5.	price		
6.	week		
2)			
1.	eye	_____	body part that sees (جزء من الجسم يسمح لنا بالرؤية)
2.	father	_____	parent who is a man (أحد الوالدين الرجل)
3.	night	_____	part of the day with no sun (جزء من اليوم لا تظهر به الشمس)
4.	van		
5.	voice		
6.	year		
3)			
1.	center	_____	brother of your mother or father (أخ الأم أو الأب)
2.	note	_____	middle (منتصف أو مركز)
3.	state	_____	short piece of writing (كتابة قصيرة على ورقة)
4.	tomorrow		
5.	uncle		

6.	winter		
4)			
1.	box	_____	family member (أحد أفراد العائلة)
2.	brother	_____	sixty minutes (60 دقيقة)
3.	horse	_____	way of doing things (طريقة لفعل الأشياء)
4.	hour		
5.	house		
6.	plan		
5)			
1.	animal	_____	green leaves that cover the ground (أوراق خضراء تغطي الأرض)
2.	bath	_____	place to wash (المكان المستخدم للاستحمام)
3.	crime	_____	top end of your arm (الجزء الأعلى من الذراع)
4.	grass		
5.	law		
6.	shoulder		
6)			
1.	drink	_____	get ready (يستعد)
2.	educate	_____	make a happy sound (يصدر صوت يدل على السعادة)
3.	forget	_____	not remember (لا يتذكر)
4.	laugh		
5.	prepare		
6.	suit		

2000 level 1)			
1.	copy	_____	end or the highest point (أعلى نقطة، القمة)
2.	event	_____	this moves a car (محرك سيارة)
3.	motor	_____	thing made to be like another (شيء تم صنعه ليكون مشابهاً لشيء آخر)
4.	pity		
5.	profit		

6.	tip		
2)			
1.	accident	_____	loud deep sound (صوت عالي و قوي)
2.	debt	_____	something you must pay (ما يجب دفعه)
3.	fortune	_____	having a high opinion of yourself
4.	pride		(امتلاك وجهة نظر عالية عن نفسك)
5.	roar		
6.	thread		
3)			
1.	birth	_____	game (لعبة)
2.	dust	_____	winning (فوز)
3.	operation	_____	being born (ولادة)
4.	row		
5.	sport		
6.	victory		
4)			
1.	clerk	_____	a drink (مشروب)
2.	frame	_____	office worker(موظف بمكتب)
3.	noise	_____	unwanted sound (صوت غير مرغوب)
4.	respect		
5.	theatre		
6.	wine		
5)			
1.	dozen	_____	chance (فرصة)
2.	empire	_____	twelve (اثنا عشر)
3.	gift	_____	money paid to the government (مبلغ يتم دفعه للدولة)
4.	opportunity		
5.	relief		
6.	tax		
6)			
1.	admire	_____	make wider or longer (يتوسع أو يكبر)

2.	complain	_____	bring in for the first time (يقدم أو يتم تقديمه لأول مرة)
3.	fix	_____	have a high opinion of someone (يعجب بشخص ما)
4.	hire		
5.	introduce		
6.	stretch		

3000 level:			
1)			
1.	bull	_____	formal and serious manner (طبع أو سلوك جاد و رسمي)
2.	champion	_____	winner of a sporting event (الفائز بحدث رياضي)
3.	dignity	_____	building where valuable objects are shown
4.	hell		(مبنى يتم فيه عرض لأشياء ذات قيمة)
5.	museum		
6.	solution		
2)			
1.	blanket	_____	holiday (إجازة)
2.	contest	_____	good quality (نوعية جيدة)
3.	generation	_____	wool covering used on beds
4.	merit		(شيء مصنوع من صوف يستخدم على الأسرة)
5.	plot		
6.	vacation		
3)			
1.	apartment	_____	a place to live (مكان للمعيشة)
2.	candle	_____	chance of something happening (متوقع حدوثه)
3.	draft	_____	first rough form of something written
4.	horror		(أول نسخة يتم كتابتها عن شيء ما)
5.	prospect		
6.	timber		
4)			
1.	administration	_____	group of animals (قطيع من الحيوانات)
2.	angel	_____	spirit who serves God (روح خُلقت لخدمة الله)

3.	frost	_____	managing business and affairs (إدارة الأعمال و المهام)
4.	herd		
5.	fort		
6.	pond		
5)			
1.	atmosphere	_____	advice (نصيحة)
2.	counsel	_____	a place covered with grass (مكان مغطى بالعشب)
3.	factor	_____	female chicken (أنثى الدجاج)
4.	hen		
5.	lawn		
6.	muscle		
6)			
1.	brilliant	_____	thin (نحيف)
2.	distinct	_____	steady (ثابت)
3.	Magic	_____	without clothes (بدون ملابس)
4.	Naked		
5.	slender		
6.	Stable		

5000 level 1)			
1.	balloon	_____	bucket (دلو، سطل)
2.	federation	_____	unusual interesting thing (شيء غير معتاد و مثير)
3.	novelty	_____	rubber bag that is filled with air
4.	Pail		(كيس من مطاط يتم ملئه بالهواء)
5.	veteran		
6.	ward		
2)			
1.	bleed	_____	come before (يسبق، يتقدم على)
2.	collapse	_____	fall down suddenly (ينهار فجأة)
3.	precede	_____	move with quick steps and jumps

4.	reject		(يمشي بخطوات و قفزات سريعة)
5.	skip		
6.	tease		
3)			
1.	casual	_____	sweet-smelling (رائحة جميلة)
2.	desolate	_____	only one of its kind (فريد من نوعه)
3.	fragrant	_____	good for your health (صحي ، مفيد للصحة)
4.	radical		
5.	unique		
6.	wholesome		
4)			
1.	gloomy	_____	empty (خالي أو شاغر)
2.	gross	_____	dark or sad (كئيب أو مظلم)
3.	infinite	_____	without end (غير منتهي)
4.	limp		
5.	Slim		
6.	vacant		
5			
1.	abolish	_____	bring to an end by law (يتم إلغاؤه بالقانون)
2.	drip	_____	guess about the future (يتنبأ المستقبل)
3.	insert	_____	calm or comfort someone (يخفف عن شخص ما)
4.	predict		
5.	soothe		
6.	thrive		
6)			
1.	blend	_____	mix together(يخلط ، يمزج أشياء مع بعضها البعض)
2.	devise	_____	plan or invent (يبتكر)
3.	hug	_____	hold tightly in your arms (تمسك شيء ما بقوة بين ذراعيك)
4.	lease		
5.	plague		
6.	reject		

Appendix (7)

Sub-lexical Knowledge Measures

الرقم الجامعي: _____

هذا الاختبار يتكون من ثلاثة أجزاء و كل جزء يتكون من عشرة فقرات، لن تحتاجي لأكثر من 10 دقائق لإكمال الأجزاء الثلاثة.

Section one: affixes form

أمامك عدد من الاختيارات التي تتضمن خياراً واحداً صحيحاً و هذا الخيار إما بادئة أو لاحقة لغوية صحيحة تضاف للمفردة الإنجليزية:

Examples:

1) a. -ful b. -une c. -ack d. -rse **such as in beautiful**

2) a. ka b. ze- **c. de-** d. ti- **such as in decrease**

1. a. inter-	b. isl-	c. ialr-	d. ier-
2. a. nid-	b. mid-	c. lio-	d. diy-
3. a. pse-	b. sarp-	c. suu-	d. super-
4. a. non-	b. nno-	c. oni-	d. noo-
5- a. sa-	b. ez-	c. ex-	d- asx-
6. a. multi-	b- mul-	c. mlt-	d. tui-
7. a. -ney	b. -ous	c. -oep	d. -ime
8. a. -f	b. -y	c. -h	d. -j
9. a. -rt	b. -al	c. -ut	d. -mb
10. a. -aedia	b. -lors	c. -atg	d. -ation
11. a. -ique	b. -less	c. -eeve	d. -itle
12. a. -gu	b. -age	c. -eg	d. -ga

Section two: affixes meaning.

اختاري الإجابة الصحيحة من بين الخيارات و التي تمثل معنى البادئة أو اللاحقة التي تضاف للمفردة الإنجليزية و التي تغير معنى المفردة بعد أن تضاف، قد تم تزويدك بأمثلة لمفردتين تحتويان على تلك الإضافة، الأمثلة ستساعدك لمعرفة المعنى الصحيح لتلك الإضافة:

Examples:

- mis- (misunderstand, mislead)

a. right (صحيح) **b. wrong** (خاطئ) c. usual (معتاد) d. middle (بالوسط)

- -er (engineer, teacher)

a. not (ليس) b. amount (مقدار) c. after (بعد) **d. person** (شخص)

1.un- (unhappy, unfair)			
a. again (مرة أخرى)	b. no (ليس)	c. back (خلف)	d. new (جديد)
2. re- (rebuild, return)			
a. opposite (ضد أو عكس)	b. wrong (خاطئ)	c. again (مرة أخرى)	d. less (أقل)
3.over- (overall, overweight)			
a. bove (فوق أو أعلى)	b. not (ليس)	c. below (تحت)	d. lack (عدم وجود)
4. pre- (prehistoric, preschool)			
a. after (بعد)	b. less (أقل)	c. again (مرة أخرى)	d. before (قبل)
5. uni- (unisex, unicorn)			
a. one (واحد)	b. person (شخص)	c. not (ليس)	d. under (تحت)
6. anti- (antibiotic, antisocial)			
a. past (ماضي)	b. against (ضد)	c. many (عديد)	d. person (شخص)

7. -hood (childhood, motherhood)			
a. one (واحد)	b. halfway (منتصف الطريق)	c. bad (سيء)	d. a state of (حالة لشيء ما)
8. -en (wooden, golden)			
a. made of (صُنع من)	b. opposite (ضد)	c. beyond (أبعد)	d. one (واحد)
9. -ward (upward, backward)			
a. direction (اتجاه)	b. person (شخص)	c. many (متعدد)	d. past (ماضي)
10. -ic (economic, energetic)			
a. more than one (أكثر من واحد)	b. after (بعد)	c. amount (مقدار)	d. characteristics of (صفة ل)

Section three: affixes function

Choose the correct part of speech for words formed with a given prefix or suffix. For each prefix of suffix, two example words are given to help you determine the part of speech. Please choose the 'I do not know' option in case you don't know:

إلحاق المفردة اللغوية بإحدى الإضافات التالية (بادئة أو لاحقة لغوية) سيغير نوع المفردة اللغوية مثلاً من فعل لاسم أو من اسم لصفة، أرجو منك اختيار نوع المفردة بعد إضافة إحدى الإضافات التالية، تم تزويدك بمثال لمفردة معروفة تحتوي على الإضافة لمساعدتك على تحديد نوع المفردة اللغوية سواء كانت اسم، فعل، صفة، حال:

Examples:

1. em- (**em**power)

a. noun (اسم) **b. verb (فعل)** c. adjective (صفة) d. adverb (حال)

2. -able (comfort**able**)

a. noun (اسم) b. verb (فعل) **c. adjective** (صفة) d. adverb (حال)

1. -ent (differ**ent**)

a. Noun	b. Verb	c. adjective	d. adverb
2. -ly (quick**ly**)			
a. Noun	b. Verb	c. adjective	d. adverb
3. -ment (enjoy**ment**)			
a. Noun	b. verb	c. adjective	d. adverb
4. -ness (happi**ness**)			
a. Noun	b. verb	c. adjective	d. adverb
5. -ish (self**ish**)			
a. Noun	b. verb	c. adjective	d. adverb
6. -ive (act**ive**)			
a. Noun	b. verb	c. adjective	d. adverb
7. -dom (free**dom**)			
a. Noun	b. verb	c. adjective	d. adverb
8. -ize or -ise (general**ize**/ general**ise**)			
a. Noun	b. verb	c. adjective	d. adverb
9. en- (enjoy)			
a. noun	b. verb	c. adjective	d. adverb
10. -ship (friend**ship**)			
a. Noun	b. verb	c. adjective	d. adverb

Appendix (8)

Lexical Decision Task

ارجو منك أن تقرر بسرعة و بدقة إذا كنت تعرف الكلمة الظاهرة أمامك أو لا و ذلك بالضغط على السهم الايسر للاجابة بلا و الايمن بنعم.

Please decide as quick and accurate as possible as you can whether you know a word or not by pressing the right or left arrows.

Real words		Fillers
1. history	2. general	1. phoncher
3. sweet	4. promise	2. kaphridge
5. sound	6. popular	3. toag
7. product	8. successful	4. petrang
9. middle	10. restaurant	5. freggy
11. image	12. talked	6. contie
13. culture	14. stranger	7. hife
15. anything	16. able	8. shrag
17. window	18. weight	9. imspl
19. buy	20. finding	10. trilst
21. green	22. painting	11. ipsidom
23. private	24. design	12. lenk
25. similar	26. visit	13. dissaified
27. bring	28. control	14. wickl
29. little	30. expensive	15. horozo
31. poor	32. driver	16. moffat
33. science	34. afraid	17. ralling
35. repeated	36. wonderful	18. webbert
37. details	38. mistake	19. targle
39. mistake	40. connect	20. ludierous

Appendix (9)

Sub-lexical Processing Efficiency Task

1-Separability task	
ارجو منك أن تقرر بسرعة و بدقة إذا كانت الكلمة الظاهرة أمامك يمكن أن تقسم أو لا إلى أصل و إضافة و ذلك بالضغط على السهم الايسر للاجابة بلا و الايمن بنعم. علما بأن أول أمثلة تجريبية للتأكد من فهمك للمطلوب.	
Please decide as quick and accurate as possible as you can whether you a word could be divided into a stem and affix or not by pressing the right or left arrows.	
Note: the first few words are just trial to assure your understanding of the task.	
Trial examples: **c**orner teacher unusual	
Test items	
1- interaction	**2-** family
3- weather	**4-** information
5- Travel	**6-** power
7- disappear	**8-** king
9- difficult	**10-**disadvantage
11-follow	**12-**cycle
13-complete	**14-**sleep
15-return	**16-**midterm
17-shadow	**18-**happy
19-unfair	**20-**rainy
21-creator	**22-**visitor
23-garden	**24-**kitchen
25-strengthen	**26-**golden
27-example	**28-**famous
29-government	**30-**relaxation

2- Combinability task

ارجو منك أن تقرر بسرعة و بدقة إذا كانت الكلمة الظاهرة أمامك يمكن أن تكون كلمة صحيحة أو لا و ذلك بالضغط على السهم الايسر للاجابة بلا و الايمن بنعم. علما بأن أول أمثلة تجريبية للتأكد من فهمك للمطلوب.

Please decide as quick and accurate as possible as you can whether a stem and an affix could be combined to be a correct English word or not by pressing the right or left arrows.

Note: the first few words are just trial to assure your understanding of the task.

Trial examples: dis- + honest= dishonest

read + -ful= readful

Test Items

1. send + -less = sendless	2. un- + home = unhome
3. weak + -ness = weakness	4. il- + write = ilwrite
5. super- + walk = superwalk	6. reason + -able = reasonable
7. number + -ness = numberness	8. un- + able = unable
9. big + -y = bigy	10. fear + -less = fearless
11. nice + -ation = nicetation	12. cloud + -y = cloudy
13. super- + star = superstar	14. non- + stop = nonstop
15. like + -ship = likeship	16. post- + large = postlarge
17. under- + age = underage	18. in- + family = infamily
19. word + -able = wordable	20. mini- + bus = minibus
21. a- + wake = awake	22. happy + -or = happyor
23. ex- + port = export	24. human + -ist = humanist

Appendix (10)

Working Memory Task

1-Forward digit span task	
ارجو منك أن تقرر بسرعة و بدقة إذا كانت الأرقام الظاهرة أمامك مرتبة حسب ظهورها سابقا أو لا و ذلك بالضغط على السهم الايسر للاجابة بلا و الايمن بنعم. Please decide as quick and accurate as possible as you can whether the numbers are ordered as they have already appeared or not by pressing the right or left arrows.	
As they appear	**The right choice**
Two digits	
1. 7 2	(2. 7)
2. 5 8	(5. 8)
Three digits	
3. 5 8 2	(5. 8. 2)
4. 6 9 4	(9. 4. 6)
Four digits	
5. 7 2 8 6	(7.2.8.6)
6. 6 4 3 9	(6.3.9.4)
Five digits	
7. 4 2 7 3 1	(4.2.7.3.1)
8. 7 5 8 3 6	(7.5.8.3.6)
Six digits	
9. 5 7 1 9 4 6	(5.7.1.9.4.6)
10.2 9 4 7 3 8	(2.9.4.8.3.7)

2-Backward digit span task	
ارجو منك أن تقرر بسرعة و بدقة إذا كانت الأرقام الظاهرة أمامك مرتبة عكس ظهورها سابقا أو لا و ذلك بالضغط على السهم الايسر للاجابة بلا و الايمن بنعم. Please decide as quick and accurate as possible as you can whether the numbers are backward ordered as they have already appeared or not by pressing the right or left arrows.	
As they appear	**The right choice**
Two digits	
1. 6 9	(9. 6)
2. 3 5	(3. 5)
Three digits	
3. 6 2 9	(9.2.6)
4. 4 1 5	(4.5.1)
Four digits	
5. 3 2 7 9	(9.7.2.3)
6. 1 9 6 8	(8.6.9.1)
Five digits	
7. 1 5 2 8 6	(6.8.1.5.2)
8. 6 1 8 4 3	(3.4.8.1.6)
Six digits	
9. 5 3 9 4 1 8	(8.1.4.5.3.9)
10.7 2 4 8 5 6	(6.8.4.2.7.5)

Appendix (11)

Syntactic Knowledge Measure

الرقم الجامعي: _____

كل جملة من الجمل التالية تحتوي على خطأ لغوي واحد فقط، أرجو منك تحديد رقم الخطأ اللغوي و كتابته في المكان المحدد، ثم محاولة تصحيحه:

The sentence	error number	Its correction
Examples: **1. You must drive careful because of the storm.** **(1) (2) (3)**	**(2)**	**Carefully**
2. I don't have many time today but I'll do it by the end of the week. **(1) (2) (3)**	**(2)**	**Much**
1. I do not never drink coffee in the morning. (1) (2) (3)		
2. What you mean? I have already told you many times. (1) (2) (3)		
3. She has win the prize. (1) (2) (3)		
4. It is raining. It often raining in Autumn. (1) (2) (3)		
5. How many cheese do you need? (1) (2) (3)		
6. I did not had to wait long for a train last night.		

(1) (2) (3)		
7. She goes always home at 5 o'clock. (1) (2) (3)		
8. Did you see this cute dogs in the park? (1) (2) (3)		
9. Yesterday was first of March. I had an appointment. (1) (2) (3)		
10. This is the man which house is on fire. (1) (2) (3)		
11. Mine favorite color is purple. I love purple things. (1) (2) (3)		
12. In the dining room, we have a table small. (1) (2) (3)		
13. Both my mother and my father is teachers. (1) (2) (3)		
14. The meeting is in 3 pm. (1) (2) (3)		
15. I bought a new iPod so I can listen to a music at the gym. (1) (2) (3)		

Appendix (12)

Semantic Network Knowledge Measure

الرقم الجامعي: _____

هذا الاختبار يتكون من قسمين و كلا القسمين عن العلاقات بين المعاني للمفردة اللغوية، الجزء الأول عن الترادف و التضاد و جزء من كل، بينما الجزء الثاني عن المتلازمات اللغوية، علماً بأن الإجابة على الجزئين لن تستغرق أكثر من 10 دقائق:

Section one:

قومي باختيار الإجابة الصحيحة للمفردة المرتبطة بالمعنى (كمرادفات، تضاد، أو جزء من كل) من الخيارات المتعددة لكل مفردة مقدمة، سيتم شرح بعض الأمثلة لتساعدك في فهم المطلوب: **Examples:**				
1. Easy	a. soft	**b. <u>simple</u>**	**c.** polite	d. nervous
In this example the correct choice is a synonym ترادف				
2. beautiful	a. quiet	b. sad	c. lonely	**d. <u>ugly</u>**
In this example the correct choice is an antonymy تضاد				
3. colour	**a. <u>red</u>**	b. time	c. pencil	d. flower
In this example the correct choice is a hyponymy 'red' (a word or phrase whose semantic field is more specific than its hypernym) of its hypernym colour جزء من كل				
• **synonyms ترادف**				
1. ready	a. late	b. prepared	c. afraid	d. lazy
2. accept	a. borrow	b. touch	c. agree	d. buy
3. option	a. choice	b. unit	c. answer	d. chance
4. journal	a. magazine	b. letter	c. note	d. book
5. couple	a. race	b. three	c. pair	d. group
• **antonyms تضاد**				

6. male	a. woman	b. child	c. person	d. aged
7. doctor	a. health	b. patient	c. medicine	d. paperwork
8. enemy	a. tribe	b. war	c. friend	d. fight
9. shortly	a. directly	b. later	c. again	d. first
10. forget	a. remember	b. follow	c. learn	d. get
• **hyponymy جزء من كل**				
11. move	a. sleep	b. swim	c. forget	d. listen
12. fruit	a. milk	b. house	c. banana	d. spoon
13. building	a. device	b. books	c. house	d. numbers
14. vehicle	a. car	b. family	c. work	d. tree
15. tool	a. shape	b. hammer	c. kitchen	d. office

Section two

Choose the possible word that could come with the cue word whether after it or before it as collocation (always linked): **قومي باختيار الخيار الصحيح و الذي يمثل المفردة المرتبطة دائماً بالمفردة المقدمة من الخيارات المتعددة سواء قبلها أو بعدها، تم تزويدك بمثال ليساعدك في فهم المطلوب.**				
Example: New	**a. <u>year</u>**	b. forever	c. soon	d. large
New **year** **Year** is linked to new over the other choices				
1. fully ____	a. colorful	b. aware	c. wonderful	d. amazing
2. do your __	a. bed	b. food	c. homework	d. writing
3. saving ___	a. time	b. sound	c. present	d. age
4. take ___	a. risk	b. danger	c. threat	d. death

5. bottle of __	a. tea	b. water	c. coffee	d. chocolate
6. speak ___	a. totally	b. largely	c. easily	d. clearly
7. ____ a wish	a. Create	b. build	c. form	d. make
8. ____ rain	a. Heavy	b. huge	c. strong	d. big
9. ____ line	a. High	b. long	c. tall	d. large
10.____ food	a. Fast	b. rapid	c. speed	d. hurry
11.___ mistake	a. Give	b. make	c. act	d. type
12.___ license	a. driving	b. reading	c. working	d. arranging
13.____ started	a. Give	b. make	c. grow	d. get
14.____ smell	a. Active	b. strong	c. able	d. firm
15.____ a cold	a. Met	b. suffered	c. caught	d. faced