

COGNITIVE AND LINGUISTIC FACTORS OF READING
ARABIC: THE ROLE OF MORPHOLOGICAL AWARENESS IN READING

By

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Abstract

Scientific reading research has produced substantial evidence linking specific reading components to a range of constructs including phonological awareness (PA), morphological awareness, orthographic processing (OP), rapid automatized naming, working memory and vocabulary. There is a paucity of research on Arabic, although 420 million people around the world (Gordon, 2005) speak Arabic. As a Semitic language, Arabic differs in many ways from Indo-European languages.

Over the past three decades, literacy research has begun to elucidate the importance of morphological awareness (MA) in reading. Morphology is a salient aspect of Arabic word structure. This study was designed to (a) examine the dimensions underlying MA in Arabic; (b) determine how well MA predicts reading; (c) investigate the role of the standard predictors in different reading outcomes; and (d) investigate the construct of reading in Arabic. This study was undertaken in two phases.

In Phase I, 10 MA measures and two reading measures were developed, and tested in a sample of 102 Grade 3 Arabic-speaking children. Factor analysis of the 10 MA tasks yielded one predominant factor supporting the construct validity of MA in Arabic. Hierarchical regression analyses, controlling for age and gender, indicated that the MA factor solution accounted for 41–43% of the variance in reading.

In Phase II, the widely studied predictor measures were developed for PA and OP in addition to one additional measure of MA (root awareness), and three reading measures. In Phase II, all measures were administered to another sample of 201 Grade 3 Arabic-speaking children. The construct of reading in Arabic was examined using factor analysis. The joint and unique effects of all standard predictors were examined using different sets of hierarchical regression

analyses. Results of Phase II showed that: (a) all five reading measures loaded on one factor; (b) MA consistently accounted for unique variance in reading, particularly in comprehension, above and beyond the standard predictors; and (c) the standard predictors had differential contributions. These findings underscore the contribution of MA to all components of Arabic reading. The need for more emphasis on including morphology in Arabic reading instruction and assessment is discussed.

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Table of Contents

Abstract	ii
Acknowledgements	iv
List of Tables	x
Chapter 1 Introduction	1
Statement of the Problem and Rationale for Current Study	5
Purpose of the Study and Research Questions	6
Outline of Dissertation	9
Chapter 2 Review of the Literature	10
Scientific Support for Predictors of Reading	10
Relationships between phonological awareness and reading	11
Relationships between phonetic recoding in working memory and reading	15
Relationships between phonological recoding in lexical access and reading	16
Relationships between the semantic and syntactic domains and reading	20
Relationships between orthographic awareness and reading	23
Relationships between morphological awareness and reading	27
Methodologies for Assessing Morphological Awareness	30
Arabic Orthography	39
Arabic Morphology	42
Review of the Arabic Literature	48
Limitations of previous studies	61
Chapter 3 Method	63

Phase I (Pilot Study): Investigating the dimensionality of MA in Arabic and its relationship	
with reading.....	64
Participants	64
Procedure	64
MA measures	65
MA task 1(written): sentence selection.....	67
MA task 2 (written): Sentence completion	67
MA task 3 (written): Morphological decomposition.	67
MA task 4 (written): Morphological composition	68
MA task 5 (oral): Morphological relation judgment.....	68
MA task 6 (oral): Standard word analogy.	69
MA task 7 (oral): Local word analogy	69
MA task 8 (oral): Sentence analogy.....	70
MA task 9 (oral): Word analysis	70
MA task 10 (oral): Picture choice	71
Reading measures	71
Word reading	71
Pseudoword reading.....	72
Data analysis (Phase I)	73
Phase II: Investigating Linguistic and Cognitive Skills in Component Skills of Reading	73
Participants	73
Procedure	74
Experimental measures.....	76

Cognitive predictor measures.	76
Verbal and nonverbal ability.	76
Memory.	77
Rapid automatized naming (RAN).	77
Linguistic predictor measures.	77
Phonological awareness.	77
Orthographic processing.	78
Morphological awareness.	79
Reading outcome measures.....	83
Word reading.....	83
Pseudoword reading.....	84
Word-reading fluency	84
Text-reading fluency.	85
Maze comprehension.	85
Data analysis (Phase II)	86
Chapter 4 Results	87
Phase I (Pilot Study).....	87
Phase II.....	92
Dimensionality of Morphological Awareness (Phase II).....	98
Hierarchical Regression Analyses	100
Prediction of word reading.....	101
Prediction of pseudoword reading	104
Prediction of word- and text-reading fluency.	105

Prediction of reading comprehension.	110
Dimensionality of reading	120
Prediction of reading as one construct.	121
Chapter 5 Discussion	123
Research Questions	124
Limitations	137
Future Research and implications for Practice.....	138
References.....	142
Appendix A Ethics Documents	174
Appendix B Overview of Morphological Awareness (MA) tasks	187
Appendix C Arabic Study Measures.....	188
Reading Measures	188
Word reading.	188
Pseudoword reading.	192
Word-reading fluency.	193
Text-reading fluency.	195
Maze reading comprehension passages.	196
Phonological Awareness.....	198
Syllable deletion.	198
Phoneme deletion.	199
Final phoneme deletion.....	199
Middle phoneme deletion.	200
Initial phoneme deletion.	201

Blending.....	201
Orthographic Processing	202
Word chains.	202
Orthographic choice.	203
Morphological Awareness	205
Root awareness.	205
Standard word analogy.	207
Local word analogy.	208
Morphological decomposition.....	209
Sentence completion.....	210

List of Tables

1. Examples of Modern Standard Arabic and Spoken Arabic	41
2. Examples of Roots and Productive Word Patterns	44
3. MA Tasks based on Deacon et al. (2008) Taxonomy	66
4. Test Measures that Served as Control and Outcome Variables.....	75
5. Description of Morphological Awareness Measures	82
6. Summary of descriptive statistics on all tasks (N = 102)	89
7. Correlations between Morphological Awareness (MA) Measures	90
8. Summary of MA Principal Axis Factor analysis (N = 102).....	91
9. Summary of Hierarchical Regression Analyses Predicting Real Word and Pseudoword Reading	92
10. Raw Scores Descriptive Statistics of all Measures (N = 194)	95
11. Transformed Scores (N = 194)	96
12. Correlations between transformed variables (predictors and reading outcomes).....	99
13. Summary of Morphological Awareness Principal Axis Factor analysis (N = 194)	100
14. Hierarchical Regression Model for the Prediction of Word Reading	102
15. Hierarchical Regression Model for the Prediction of Word Reading with the Order of Predictors Entered in Reverse	103
16. Hierarchical Regression Model for the Prediction of Pseudoword Reading	105
17. Hierarchical Regression Model for the Prediction of Word-Reading Fluency	107
18. Hierarchical Regression Model for the Prediction of Text-Reading Fluency.....	108

19. Hierarchical Regression Model for the Prediction of Text-Reading Fluency Including Word-Reading Fluency as a Control.....	109
20. Hierarchical Regression Model for the Prediction of Reading Comprehension	112
21. Hierarchical Regression Model for the Prediction of Reading Comprehension Including Word- Reading Fluency as a Control.....	113
22. Hierarchical Regression Model for the Prediction of Reading Comprehension Including Text- Reading Fluency as a Control.....	116
23. Hierarchical Regression Model for the Prediction of Reading Comprehension Including Word Reading as a Control	117
24. Summary of all Hierarchical Regression Analyses for All Predictors and all Reading Outcomes	119
25. Summary of Reading Measures Principal Axis Factor Analysis	121
26. Hierarchical Regression Model for the Prediction of Overall Reading (Reading Factor Score)	122

Chapter 1

Introduction

The mechanisms underlying reading acquisition in typically developing children is a topic that has been heavily investigated in English, other alphabetic languages, and in non-alphabetic languages. Reading refers to the understanding of language that is written down (Ziegler & Goswami, 2005). Over the last 25 years, scientists from various disciplines, including cognitive psychology, linguistics, education, and neuroscience have focused on: (a) studying reading achievement as a single construct as well as select components skills of reading shown to be essential to skilled reading development; and (b) understanding why different patterns of relationships exist between oral and written language, and between component skills of reading (e.g., decoding and comprehension) (e.g., Oakhill, Cain, & Bryant, 2003) in populations of children struggling to learn to read (Aaron, Joshi, & Williams, 1999; Bishop & Snowling, 2004; Carver & Clark, 1998; Gough & Tunmer, 1986; Oakhill et al., 2003; Stanovich, 2000). Varying patterns among skills associated with reading success have motivated cognitive scientists, in particular, to question the contribution of select non-reading skills, such as phonological manipulation and memory, to skilled reading (Baddeley, 1986, 2000, 2003; Goswami & Bryant, 1990; Liberman, Liberman, Shankweiler, Fischer, & Carter, 1974; Wagner, & Torgesen, 1987). Issues of this nature have led to a rich body of cross-linguistic reading research into children's varied reading abilities/disabilities. The focus of much of this research has been on studying contributions of component skills of reading and select cognitive behaviors to the larger construct of "reading achievement."

Previous research in English and other alphabetic orthographies has produced substantial evidence linking a range of constructs to specific reading components. These constructs include

phonological awareness (PA), morphological awareness (MA), orthographic processing (OP), rapid automatized naming (RAN), phonological working memory, and vocabulary. All these constructs have been shown to contribute to some degree to component skills of reading such as word recognition, reading fluency, and reading comprehension (for review, see National Reading Panel, 2000). These relationships exist across languages studied to date (e.g., Abu-Rabia & Siegel, 2002; Catts, Fey, Zhang, & Tomblin, 2001; de Jong & van der Leij, 1999, 2002; Ho, Chan, Tsang, & Lee, 2002; Rahbari, Sénéchal, & Arab-Moghaddam, 2007; Sénéchal, 2000; Wimmer, Mayringer, & Landerl, 2000). Exploration of the multidimensional nature of reading (Adlof, Catts, & Little, 2006; Lombardino, 2012; Silverman, Speece, Haring, & Ritchey, 2013) is essential for an in-depth understanding of the confluence factors that contribute to this complex skill of reading (Badian, 1982; Baddeley, 2003; Kim & Wagner, 2015). Numerous researchers (Bishop & Snowling, 2004; King, Giess, Lombardino, 2007; Vellutino, & Fletcher, 2004) have cogently shown that weaknesses in the development of reading in children with learning disabilities result from core weaknesses in specific components of reading, and that core areas of weakness vary across populations of children. The most widely referenced examples of how degrees of strength and weakness in component skills of reading occur are found in descriptions of children who excel in decoding words but demonstrate poor listening and reading comprehension (Cain, 2010; Nation, 1999) and, in contrast, those who struggle with decoding and word recognition but comprehend (Elbro & Arnbak, 1996; Quémart & Casalis, 2015).

In short, reading requires a set of skills that together allow us to identify printed words and to comprehend text. Component skills of reading and specific non-reading skills differentially contribute to the skill of reading as defined above. For example, word recognition rests on the phonological aspects of language, while reading comprehension rests on the

semantic aspects of language as well as fluent reading (Fuchs, Fuchs, Hosp, & Jenkins, 2001). Combined together, these different cognitive foundations contributed to the complexity of reading.

To date, research into the component skills of reading and the cognitive underpinnings of reading has focused mostly on Indo-European languages (Share, 2008). Languages vary in their spoken language form and content and in their writing systems (orthography). Such diversity in orthography has been shown to affect the way and rate at which reading is acquired (Katz & Frost, 1992; Seymour, Aaro, & Erskine, 2003). Thus, an understanding of the specific linguistic and cognitive underpinnings of different languages is essential in designing scientifically accurate assessments to study reading skills across languages and to provide evidence-based interventions for children learning to read, when necessary.

Research has clearly shown that phonemic awareness is the strongest linguistic predictor of individual differences in reading development across all alphabetic languages (Melby-Lervag, Lyster, & Hulme, 2012; Share, 1995). This finding is the basis for the phonological deficit hypothesis of dyslexia, which posits that deficits in the phonological domain of language underlie the reading deficits that characterize dyslexia (Shaywitz, 2003), the most frequently diagnosed specific learning disorder (Vellutino & Fletcher, 2005). While the literature on dyslexia is not addressed explicitly in this current research, it is important to underscore that deficits in phonemic awareness observed in children with dyslexia across all alphabetic and non-alphabetic languages studied have provided reading researchers with a solid foundation for studying the contributions of component skills of language (i.e., phonological, morphological, semantic, and syntactic) along with other cognitive skills (e.g., memory, attention, processing

speed) to the acquisition of skilled reading (Breznitz, 2008; Hulme & Snowling, 2009; Snowling, 2000; Stanovich, 1988a, 1988b; Vellutino, Fletcher, Snowling, & Scanlon, 2004).

With the sound understanding of the established role of phonemic awareness, reading researchers have begun to address the importance of morphology as a core skill in literacy development. Bowers and colleagues (Bowers & Kirby, 2010; Bowers, Kirby, & Deacon, 2010) assigned morphology a central role in the *triangle model* of word-reading proposed by Seidenberg and McClelland (1989) several decades ago. They posit that morphological knowledge is a plausible constituent binding agent, a kind of “lexical representation glue that contributes to and strengthens knowledge of word meanings” (Bowers & Kirby, 2010, p. 534). Although it can be argued that morphological awareness is part of vocabulary, empirical evidence supports that morphological awareness is a separate construct from vocabulary (Berninger, Abbott, Nagy, & Carlisle, 2010; Tighe & Schatschneider, 2015). Berninger et al. (2010) stated that:

Although vocabulary knowledge may predict two kinds of morphological awareness, it does not predict all kinds of morphological awareness. When a suffix has to be selected or added to a base word to make the suffixed word fit a particular syntactic context, vocabulary knowledge alone, while necessary, is not sufficient—additional knowledge of the word formation process is needed to support further growth in morphological awareness (p. 155).

Berninger et al. are in agreement with Nagy (2007) and Stahl and Nagy (2006) who differentiated vocabulary from word formation. There is also scientific evidence that morphological awareness accounts for unique variance in reading comprehension independent of vocabulary (Deacon & Kirby, 2004; Fowler & Liberman, 1995; Kirby et al., 2012; Mahony,

Singson, & Mann, 2000). The area of morphology is especially pertinent to the study of Arabic because word structure in Arabic is highly morphemic; that is, almost all Arabic words are derived by means of combining at least two bound morphemes (roots and word patterns) simultaneously. Furthermore, Arabic is characterized by its nonlinear morphology which is different from Indo-European languages. Nonetheless, few studies have examined the role of morphology in young Arabic readers. In addition, none of the existing Arabic studies have developed and validated authentic Arabic morphological awareness and reading measures.

Statement of the Problem and Rationale for Current Study

This study aims to address the relationships between specific component skills of reading and non-reading linguistic and cognitive processes in Arabic native-speaking Grade 3 children. Arabic is a Semitic language that is different from Indo-European languages. Therefore, findings from English may or may not generalize to Arabic. The vast majority of studies on the role of component dimensions of Arabic language focused on variables that represent some form of phonological processing, including phonological awareness and phonological memory, and a limited number of reading measures. Far fewer studies have examined the role of morphology in Arabic readers and even fewer have investigated morphological knowledge and relationships between linguistic and cognitive factors and reading ability in Arabic-speaking children. Although research on Arabic morphology has received some attention in the past few years, the majority of this research has included only skilled adult readers with a focus mainly on investigating the structure and function of roots against word-patterns as the main constituents of derivational morphology in adult participants (Boudelaa, 2014; Boudelaa & Marslen-Wilson, 2005, 2011, 2015). Furthermore, no research of Arabic has: (a) developed authentic Arabic morphological awareness and reading measures; (b) investigated the construct of morphological

awareness in young monolingual Arabic speaking students; (c) included a large sample of native Arabic-speaking children; or (d) used a wide range of validated Arabic measures of MA that cover the different dimensions (Deacon, Parrila, & Kirby, 2008). More importantly, previous studies have failed to take into account the frequency count of Arabic words in their test designs, as most reading measures used were adapted from other languages.

The constructs chosen for this study have been examined in numerous investigations of reading. They have been productive in showing individual differences in reading skills across numerous languages, and they have been shown to represent independent constructs that account for unique variance in reading achievement (Bowey, 2005; Catts et al., 2015; Deacon & Kirby, 2004; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004).

Purpose of the Study and Research Questions

This study was designed to extend the extant literature on the joint and unique effects of a number of standard predictors in reading in Arabic-speaking Grade 3 children, and to investigate the construct and role of morphological awareness (MA) in reading Arabic. Third grade children were chosen to ensure that they have finished two years of formal schooling. By the end of Grade 2, Arabic-speaking children would have been taught all the Arabic alphabets, and are able to decode and read basic texts. No study has investigated the construct of MA and examined its relationship to reading among native Arabic-speaking children using multiple measures with distinct task requirements. Given the intricate nature of morphology in Arabic orthography, this study was designed to (a) examine the dimensions underlying morphological awareness (MA) in Arabic; (b) determine how well MA predicted reading; (c) investigate the role of the standard predictors (PA, MA, OP, RAN, and cognitive abilities) in different reading outcomes (word

reading, pseudowords, word-reading fluency, text-reading fluency, and reading comprehension); and (d) investigate the construct of reading in Arabic. To this end, the following questions and predictions were formulated:

Question 1: What is the structure (Dimensionality) of Morphological Awareness in Arabic?

Prediction: Because Arabic morphology is linear and nonlinear (Boudelaa, 2014; Boudelaa & Marslen-Wilson, 2005; Abu-Rabia, 2002, 2007, 2012), and the Arabic language is diglossic (Saiegh-Haddad, 2003; 2005), it is predicted that Arabic Morphological Awareness will be at least bi-dimensional in nature (e.g., oral spoken dialect versus standard written or inflectional versus derivational).

Question 2: What are the contributions of the predictor variables of phonological awareness, orthographic processing, morphological awareness, naming, and vocabulary to individual component skills of reading for Arabic-speaking Grade 3 children?

Predictions: Phonological awareness will contribute the most variance of all predictors to vowelized word reading in Arabic because vowelized Arabic is highly transparent. Orthographic processing will contribute the most variance of all predictors to word-reading fluency because of the complexity of Arabic orthography (similar graphemes, redundant letter strings – mainly for the root morpheme and its derivatives, and ligaturing or connectivity of some letters, and the same letter changing shape depending on its position in the word). Because morphology is a salient feature of Arabic lexical structure, morphological awareness will: (1) account for a unique variance in word-reading, word- and text-reading fluency and comprehension based on previous research (Abu-Rabia, 2002, 2007, 2012; Carlisle, 2000; Kirby et al., 2012; Roman et al. 2009); and (2) explain variance in reading comprehension above and beyond that of other

predictors while controlling for word-reading based on the density of Arabic morphology and the role of morphological awareness in reading in general. Lastly, Rapid Automatized Naming (RAN) will play a significant role in text-reading fluency (Savage & Fredrickson, 2005) and in reading comprehension above that predicted by word-reading fluency based on previous literature showing that naming speed is a significant predictor of reading fluency especially in consistent orthography (Georgiou, Parrila, Kirby, & Stephenson, 2008; Kirby et al., 2003; Mann & Wimmer, 2002).

Question 3: What is the nature of the reading construct in Arabic?

Predictions: Given no other research on Arabic has investigated the construct of reading, it was deemed necessary to explore the nature of the reading construct in Arabic; that is, whether the five reading measures developed in this study represent a single construct or distinct constructs. Based on the plethora of reading research in English and other languages, the different reading components have been investigated as separate constructs. For the purpose of this study, it is predicted that the five reading measures will be strongly correlated among Grade 3 Arabic-speaking children.

In order to accomplish this line of research with Arabic-speaking children, it was necessary to conduct this study in two phases that required: (a) developing a battery of MA and reading tests; (b) piloting these tests to validate the measures developed; (c) establishing the construct and predictive validity of morphological awareness; (d) developing measures for other constructs such as phonological awareness, orthographic processing, and reading fluency and reading comprehension; (e) investigating the joint and unique effects of the standard predictors in different reading measures in Arabic; and (f) examining the dimensionality of the “reading” construct in Arabic.

Outline of Dissertation

This dissertation is organized into five chapters. In this first chapter, the statement of the problem, the purpose of the study and research questions were presented. In the second chapter, a literature review is presented which highlights the theoretical and empirical background of the study. Specifically, the second chapter includes scientific support for the widely studied standard predictors of reading, methodologies for assessing morphological awareness, a description of Arabic orthography and Arabic morphology, followed by a review of the Arabic literature and its limitations. The third chapter includes the methodology that guided this quantitative study. It includes the two phases (Phase I & Phase II) that were undertaken in this study. Each phase includes a description of the purposes, participants, procedure, and data collection. In the fourth chapter, the research results are presented. Research results are organized into two sections, result of Phase I, and results of Phase II. The final chapter presents research questions, predictions, and findings discussed in light of the existing literature. Chapter 5 also includes limitations of the current study and concludes with implications for practice and future research.

Chapter 2

Review of the Literature

This study was designed to explore the relationships between component skills of reading and other cognitive and linguistic skills in Arabic-speaking children. Arabic is a highly transparent language that is characterized by its direct relationship between its graphemes and phonemes. Almost all Arabic words, with the exception of some primitive nouns referring to body parts, are derived by means of interleaving two abstract bound morphemes (roots and word patterns) simultaneously. The area of morphology is especially pertinent to the study of Arabic because word structure in Arabic is highly morphemic; that is, almost all Arabic words are derived by means of combining two abstract bound morphemes (roots and word patterns) simultaneously. Below is a synopsis of the scientific support for the contribution of each of the constructs chosen to study (e.g., phonological awareness, orthographic awareness, morphological awareness) as predictors of specific reading measures (e.g., word reading, pseudoword reading, word-reading fluency, text-reading fluency, and reading comprehension).

Scientific Support for Predictors of Reading

The diversity in human languages and writing systems (orthographies) affects the way and rate with which reading is acquired. Although alphabetic languages share some aspects, the existing cross-linguistic studies inform us that reading processes work differently across languages, depending on characteristics of the orthography of a language (de Jong & van der Leij, 2002; Georgiou, Parrila, & Liao, 2008; Georgiou, Parrila, & Papadopoulos, 2008; Kuo & Anderson, 2006; Mann & Wimmer, 2002; Rahbari et al., 2007). Therefore, it is crucial to understand the linguistic and cognitive underpinnings of a language in order to understand the way reading develops (or fails to) in a particular linguistic and cultural environment. Indeed,

word recognition has been shown to be related to several non-reading skills including phonological awareness, rapid automatized naming, morphological awareness, orthographic processing, memory, and vocabulary knowledge (Abu-Rabia & Siegel, 2002; Baddeley, 2000, 2003; Beck & McKeown, 1991; Biemiller & Slonim, 2001; Brady, 1991; Carlisle & Nomanbhoy, 1993; Carlisle, 2000; Cunningham & Stanovich, 1997; Kirby et al., 2012; Kirby, Parrila, & Pfeiffer, 2003; Kirby, Desrochers, Roth, & Lai, 2008; National Reading Panel, 2000; Roman et al., 2009; Siegel, 1994; Wagner & Torgesen, 1987). Given the strong and well documented relationships between each of these factors and reading, the following sections introduce a review of the scientific evidence available on the relationships between the established predictors and reading in the following order: phonological awareness, phonetic recoding in working memory, phonological recoding in lexical access (rapid automatized naming), semantic and syntactic knowledge, orthographic awareness, and morphological awareness.

Relationships between phonological awareness and reading. Before introducing the scientific evidence on Phonological awareness (PA), it is important to note that the term *phonological awareness* is not the same as *phonological processing*. The term *phonological processing* is often used loosely to refer to a wide range of cognitive skills involving speech sounds. Torgesen, Wagner, and Rashotte (1994) proposed three major types of phonological processes: *phonological awareness*, *phonetic recoding in working memory*, and *phonological recoding in lexical access*. Each of these processes will be discussed beginning with phonological awareness (PA), followed by a description of phonetic recoding in working memory and phonological recoding in lexical access (rapid automatized speed).

Phonological awareness (PA) refers to the skill of knowing that oral language has a structure of sounds (Yopp & Yopp, 2000), and that this structure is separate from meaning. There is ample evidence showing that PA, broadly defined as the ability to detect or manipulate the sounds of spoken words (for review, see Anthony & Francis, 2005), is key to “cracking” the code for reading and spelling and that a deficit in PA will compromise one’s ability to achieve skilled reading (Adams, 1990; National Reading Panel, 2000; Torgesen et al., 1994). Goswami and Bryant (1990) stated that the term phonological awareness is a “blanket term” (p. 2), because the term is broad and encompasses different levels of awareness of phonology. They posited a hierarchical organization of breaking up words from the basic division at the syllable level, followed by the intra structure of each syllable referred to as the onset and rime, extending to the last and highest level of phonological awareness that refers specifically to the phoneme level. Breaking a word into its constituent phonemes is important to the child because these phonemes are represented by alphabetic letters, and the novice readers needs to learn these relationships between the letters and their corresponding phonemes (grapheme-phoneme correspondences). In fact, PA is described in the literature as a multidimensional skill that refers to a continuum of skills reflecting different developmental levels of sensitivity to the sounds in a spoken word (Gillon, 2004; Stahl & Murray, 1994; Stanovich, 1994). Phonological awareness skills develop over the course of several years extending from preschool through the early elementary school years. Indeed, Liberman and colleagues (e.g., Liberman & Liberman, 1990; Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Liberman et al., 1974) and Rosner (1974) reported evidence for a developmental progression beginning with syllable awareness and extending to the upper end of the continuum, phoneme awareness.

The research literature on the phonological domain of reading attests to the wide variety of tasks that measure the dimensions of PA reliably and validly (Adams, 1990; Yopp, 1988). At the syllable level of awareness, learners may count or tap the number of syllables in a compound word such as “birth...day” and multisyllabic words such as “cra...yon.” At the intra-syllabic awareness level (onset-rime), children learn to identify if two words begin with the same sound or not (e.g., cat, cap) or to identify a word in a group that does not rhyme (e.g., hop, mop, car). At the phonemic awareness level, the learner understands that the word “cat” has three phonemes, and the word “box” has four phonemes. Phonemic awareness requires listening and attending to the individual sounds that make up a word. Research has confirmed that segmenting words into their individual phonemes is acquired about the same time as they learn to read (Wagner & Torgesen, 1987; Liberman et al., 1974; Liberman, Shankweiler, & Liberman, 1989). This is when learners understand that words are composed of individual sounds, and these sounds correspond to specific orthographic symbols (e.g., letters). When this happens, the learner has acquired the alphabetic principle (Adams, 1990; Lombardino, 2012). Stahl and Murray (1994) defined the alphabetic principle as “the understanding that letters in written words stand for sounds in spoken words” (p. 232).

Becoming a skilled reader requires developing a level of phonological sensitivity to the sound segments of speech (Liberman, Liberman, Mattingly, & Shankweiler, 1980). The quality of phonological representations, which is how well a sound is differentiated from other sounds in the language, and its role in phonemic awareness is also crucial in reading development (Elbro, 1998, 1999; Goswami, 2000). Several researchers postulated that low-quality phonological representations yield impoverished phoneme awareness which impacts reading negatively (Elbro, Borstrom, & Petersen, 1998; Perfetti, 1985). Given this rich body of research on the

phonological contributions to reading, it is not surprising that attending to the phonological structure of one's language has been strongly linked to both reading development (Bradley & Bryant, 1983; Lonigan, Burgess, & Anthony, 2000; Snow, Burns, & Griffin, 1998; Wagner & Torgesen, 1987) and reading disability (Byrne, 1998; Elbro et al., 1998; Pennington & Lefly, 2001).

Associations between phonological awareness and oral language have also been shown in populations with language impairments. In a number of studies, it has been reported that children with a specific comprehension deficit and good word-reading skills had poor phonological awareness in preschool or kindergarten (Catts, Adlof, & Weismer, 2006; Elwér, Keenan, Olson, Byrne, & Samuelsson, 2013; Nation, Cocksey, Taylor, & Bishop, 2010). It is not surprising that children with specific language impairments who may develop good word reading skills later on, have had poor phonological skills in their preschool years (Catts & Adlof, 2011). It seems reading comprehension is deeply rooted in the foundational skills of phonological awareness either directly or mediated by word reading. In a recent longitudinal (KG-Grade 3) study by Catts, Herrera, Nielsen, and Bridges (2015), the researchers investigated the early predictors of reading comprehension within the framework of the Simple View of Reading (SVR) proposed Gough and Tunmer (1986). They employed structural equation modelling, and showed that the two components of the SVR (word reading and oral language comprehension) in kindergarten accurately predicted reading comprehension in Grade 3. This predictive ability was evident in both mediated (word reading in Grade 2) and non-mediated models. Accordingly, the researchers concluded that including oral language measures in the assessment of children at risk for reading comprehension are needed to identify children at risk for reading comprehension failure early on

prior to their formal literacy instruction (see also McCardle, Scarborough, & Catts, 2002; Catts & Kamhi, 2005).

Relationships between phonetic recoding in working memory and reading. Phonetic recoding in working memory (WM) requires individuals to briefly retain verbal material (letters, digits, words) presented auditorally or visually, and then recall this material from short-term memory. Specifically, WM requires the ability to simultaneously process and store information such as when mapping phonological units onto their corresponding orthographic units (for a list of WM tasks, see Savage, Lavers, & Pillay, 2007). Baddeley (1986, 2000) offered a multicomponent model of WM to include the phonological loop component, the visuospatial sketchpad component, and the central executive component. Baddeley later revised the model to include the episodic buffer component, which is responsible for providing and recovering information from the long term memory (see Baddeley, 2003).

An extensive body of research has established the link between working memory (WM) and reading (Baddeley, 1986, 2000, 2003; Brady, 1991; Scarborough, 1998; Siegel, 1994; Siegel & Ryan, 1989; Snowling, 1995). WM as a construct has been empirically tested and found to be highly correlated with and predict reading comprehension (Cain, Oakhill, & Bryant, 2004; Daneman & Merikle, 1996). It is assumed that limitations in WM cause speech sound codes to be less accessible for individuals with reading disabilities, which in turn slows their speech planning processes (Catts, 1993; Siegel, 1994). Weakness in WM was also reported in children with different subtypes of learning disabilities (reading, arithmetic, and attention deficit disorders) when compared to normally developing children. Furthermore, studies across several languages (Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; Girbau & Schwartz, 2008), including

Arabic (Abu-Ahmad et al., 2013; Abu-Rabia & Siegel, 2002; Saiegh-Haddad, 2005) have reported limitations in WM in children with reading disabilities.

Relationships between phonological recoding in lexical access and reading.

Phonological recoding in lexical access requires rapid retrieval of phonological codes from a long-term store, which has been traditionally assessed by rapid automatic naming (RAN) tasks such as naming a series of digits, letters or colors. Rapid Automatized Naming (RAN) or naming speed refers to the efficiency with which individuals retrieve phonological codes from long-term memory. Efficiency refers to the accuracy and speed/rate in naming stimuli. Both terminologies (RAN and naming speed) have been used interchangeably in the literature. Furthermore, RAN is usually measured in seconds or milliseconds by using a stop watch. It is worth noting that some researchers measure naming speed by reporting the time it taken to name the stimuli ignoring the number of errors, whereas other researchers reported the naming speed efficiency by dividing the number of errors by the time it took to name the stimuli.

Independent of phonological awareness deficits, RAN speed deficit has been identified as a second core deficit in children with reading disabilities (Wolf & Bowers, 2000; Wolf, Bowers, & Biddle, 2000). RAN has also been found to correlate highly with reading achievement (Bowers, 1993; Bowers & Wolf, 1993) and reading disability (Morris et al., 1998; Scarborough, 1998; Wolf et al., 2000). This rapid naming skill, both historically (Denckla & Rudel, 1976) and in contemporary research (Georgiou, Parrila, Cui, Papadopoulos, 2013; Kirby, Georgiou, Martinussen, & Parrila, 2010; Papadopoulos, Georgiou, & Kendeou, 2009), has been assessed with the task of rapid automatized naming (RAN) in which a series of simple symbols are presented visually in a closed set that is randomly arrangement with the exception that the same items are not shown contiguously. The symbols used are single letters, numbers, colours, or

pictures. RAN requires that the individual label symbol (i.e., say blue for a blue circle, dog for a picture of a dog) serially and as quickly as possible. A typical task of RAN includes 30–50 familiar items (e.g. digits, colors, or letters) repeated in a semi random series of items arranged in rows. The construct of naming speed and the reason it is related to reading is somewhat ambiguous in the sense that there are several theoretical explanations for its relationship to reading. For example, some researchers argue that naming speed is part of a more general construct of phonological processing because it requires retrieval of sounds (e.g., Torgesen et al., 1994; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997), whereas other researchers posit that general processing speed is the link between rapid naming skill and reading fluency (Kail, Hall, & Caskey, 1999). Additional interpretations of the relationship between naming speed and reading have been proposed. For example, naming speed has been linked to orthographic processing (Bowers, Golden, Kennedy, & Young, 1994; Bowers & Wolf, 1993; Manis, Seidenberg, & Doi, 1999), timing (Breznitz, 2005; Wimmer & Mayringer, 2001), and executive functions such as working memory and attention (e.g., Amtmann, Abbott, & Berninger, 2007).

The relationship between RAN and different reading measures has been heavily investigated and well documented in the literature. For example, naming speed was found to be correlated with word reading accuracy, word reading speed, text reading speed, pseudoword reading accuracy, and pseudoword reading speed, and shown to be predicted by naming speed (e.g., Bowers, 1995; Compton, DeFries, & Olson, 2001; Georgiou et al., 2008; Kirby et al., 2003; Landerl & Wimmer, 2008; Moll, Fussenegger, Willburger, & Landerl, 2009; Savage & Frederickson, 2005; Swanson, Trainin, Necoechea, & Hammill 2003). Further, RAN was found to correlate with and be predictive of reading comprehension (e.g., Arnell, Joanisse, Klein,

Busseri, & Tannock, 2009; Compton et al., 2001; Georgiou, Das, & Hayward, 2008; Kirby et al., 2003).

While RAN has been associated with various component reading skill, its strongest relationship is found with reading fluency (Bowers, 1993; Compton et al., 2001; Kirby et al., 2003; Savage & Frederickson, 2006; Young & Bowers, 1995). Some researchers have posited that RAN scores make unique contributions to the reading process independent of phonological processing (Bowers, Sunseth & Golden 1999; Manis, Doi, & Bhadha, 2000; Wimmer & Mayringer, 2002; Wolf et al., 2000). For example, in a longitudinal study, Kirby et al. (2003) examined the contributions of both phonemic awareness (measured by sound isolation, phoneme elision, phoneme blending and onset and rime blending) and RAN (color naming and picture naming) to reading. They reported that while phonemic awareness had its most robust effect in the early grades (K-Grade 2), RAN was a stronger predictor of reading in the later grades (Grades 3-5). RAN was also found to be more strongly related to reading performance in poor readers as opposed to typical readers (Roman et al., 2009; Wolf & Bowers, 1999). In a longitudinal study by Schatschneider et al. (2004), relationships between RAN and component reading skills shifted with age. RAN accounted for unique variance in reading comprehension in kindergarten and word identification and fluency at the end of Grades 1 and 2. In fact, the link between text-reading fluency and comprehension has been empirically tested in a number of studies, and results consistently confirmed that fluency plays a significant role in comprehension (Fuchs et al., 2001; Jenkins et al., 2003; Kim, Park, & Wagner, 2014; Kim, Wagner, & Lopez, 2012; Kuhn & Stahl, 2003; Riedel, 2007). In fact, reading speed was reported as an important indicator in predicting high-stakes third grade reading comprehension (Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008).

Further, the ubiquitous relationships between RAN and reading have been investigated in several Indo-European and Uralic languages (e.g., Dutch, Finnish, and German) with orthographies that are more transparent (consistent or shallow) than English. The predictive power of rapid naming in these shallow orthographies was found to be even more robust in shallow orthographies (Aro & Wimmer, 2003; Wimmer, Mayringer, & Landerl, 1998, 2000). For example, de Jong and van der Leij (1999) found that speeded naming of pictures at the beginning of kindergarten predicted 13% of variance in word and pseudoword reading rate at the end of the Grade 2, which is the grade at which Dutch-speaking children begin learning to read. Mann and Wimmer (2002) found that naming speed was the only significant predictor of reading in German-speaking children, unlike in English, where phonological awareness remains the strongest predictor of word-reading speed. However, in a cross-linguistic study comparing English to Dutch, Patel, Snowling and de Jong (2004) reported that RAN was less important than phonological awareness regardless of the transparency of the script. Although vowelized Arabic is a shallow orthography, other researchers consider it as a semi-transparent orthography due to the complexities of its orthography (e.g., allographic form and ligaturing). Whether fully transparent or semi-transparent, Tibi, Lombardino, Ho, and Park (2013) reported significant moderate correlations ($r = .51, p < .001$) between rapid serial naming and word reading in Arabic-speaking Grade 2 children. Overall findings from concurrent and longitudinal studies of the roles of PA and RAN on reading suggest that, during the early stages of developing reading, PA predicts word recognition ability but only during the initial stages of reading acquisition (Kindergarten and Grade 1). Subsequently, rapid serial naming speed appears to be a more reliable predictor of word recognition speed (Kirby et al. 2003; Verhagen, Aarnoutse, & van Leeuwe, 2008; Wimmer et al., 1998, 2000).

Relationships between the semantic and syntactic domains and reading. In addition to phonological awareness, other domains of oral language knowledge, including semantics and syntax (Scarborough, 2001), are critical for developing skilled reading (Adams, 1990; Muter, Snowling, & Taylor, 1994). The knowledge of meanings of words (i.e., vocabulary) is central to learning one's native languages, additional languages, and to the normal acquisition of reading (Biemiller, 2005, 2006; Biemiller & Slonim, 2001; Sénéchal, Ouellette, & Rodney, 2006; Stahl & Nagy, 2006). Two types of vocabulary have been identified in the literature, vocabulary breadth and vocabulary depth (Anderson & Freebody, 1981). Vocabulary breadth refers to the vocabulary size of a person, which is usually measured by standardized vocabulary tests (Lombardino, 2012). In contrast, vocabulary depth, as defined by Anderson and Freebody (1981), refers to "the quality or depth of understanding" (p. 93). Other researchers have pointed to the role of morphology in one's vocabulary depth, because knowledge of morphology enhances knowledge of word segments such as roots and affixes (Bowers & Kirby, 2010; Kieffer & Lesaux, 2008). In other words, word formation skills deepen understanding of vocabulary. Moreover, vocabulary size (i.e., breadth) appears to be mostly related to word decoding and word recognition, whereas depth of word knowledge appears to be most directly related to reading comprehension (Anderson & Freebody, 1981; Tannenbaum, Torgesen, & Wagner, 2006).

Studies have shown that vocabulary knowledge predicts overall reading ability (Kirby, Desrochers, Roth, & Lai, 2008; Sénéchal et al., 2006), and especially the comprehension component of reading (e.g., Cutting & Scarborough, 2006; Nation, 2001; Tannenbaum et al., 2006). There is also empirical evidence supporting the fact that reading plays an instrumental role in expanding one's vocabulary (Nagy & Scott, 2000). In a longitudinal study, Storch and Whitehurst (2002) found that: (a) oral language skills measured by vocabulary were found to

strongly correlate with phonological awareness in preschool; (b) oral language ability in preschool and kindergarten predicted oral language in Grades 1–2, and Grades 3–4; and (c) there was a significant correlation between oral language in Grades 3–4 and reading comprehension after controlling for concurrent and previous word reading accuracy. The researchers established an indirect causal link between early oral language ability and later reading comprehension. In the same vein, Kendeou, van den Broek, White, and Lynch (2009) reported a strong link between oral language and code-related (phonological awareness and letter knowledge) skills in preschool, but the strength of this link dropped in Kindergarten, perhaps after children had more exposure to literacy experiences. They also found that code-related and oral language skills in kindergarten were indirectly related to second grade reading comprehension. Kendeou et al.'s (2009) study and the one by the Storch and Whitehurst both indicate that code-related skills and oral language skills are highly related in the early years of preschool, and are predictive of later reading comprehension. Young children's narrative skills, as a form of oral language, were also longitudinally linked to children's vocabulary, reading and comprehension (Sénéchal, 2010, 2012; Sénéchal & LeFevre, 2014; Sénéchal & Lever, 2014).

The complexity of reading comprehension as a construct by itself has been recognized in the literature. Its complexity stems from the multi-dimensional nature of the processes and products of reading comprehension (e.g., Graesser & McNamara, 2011; Kintsch & Kintsch, 2005; Kirby, Cain, & White, 2012; Paris & Stahl, 2005). Indeed, long ago research has concluded that reading comprehension is not a unitary construct (Davis, 1994). Notwithstanding its multi-dimensionality, reading comprehension has been inadequately measured as one construct. In fact, it was not until 1997 when Nation and Snowling (1997) addressed that the reading measures tap different reading skills. More recently, Keenan and colleagues (Keenan,

Betjemann, & Olson, 2008) investigated different reading comprehension measures and reported on the split between these measures using principle component factor analysis and hierarchical regression analyses. Keenan et al. found that two of the five reading comprehension measures they included in their analyses loaded highly on decoding than on comprehension. The researchers explained that these two particular reading comprehension tests used short passages whereby an error in decoding will cause comprehension difficulties. In contrast, tests that used longer passages and had the examiner read the multiple choice questions to the examinee relied more on general knowledge and context, and decoding problems in such tests could be resolved by resorting to meaning. Accordingly, Keenan et al. (2008) concluded that comprehension tests are not comparable and advised that care should be taken when deciding on a reading comprehension test to assess and diagnose reading difficulties in children (and adults). They also emphasized that in spite of the high correlation (range .50 - .92) between reading tests, it is incorrect to assume that reading tests are interchangeable.

In addition to semantic knowledge, syntactic knowledge has been linked to reading in several studies. Cain and Oakhill (2007) distinguished between syntactic knowledge and syntactic awareness. Syntactic knowledge refers to the implicit knowledge of syntactic structures (e.g., passive-vs. active-voice construction). Syntactic awareness is also referred to as grammatical awareness, and is considered a type of metalinguistic skill that refers to the explicit knowledge of syntax (e.g., the ability to make word order corrections). It was reported that this type of awareness is related to reading skill and reading comprehension (Bowey, 1996; Cain, 2007; Nation & Snowling, 2000). The predictive power of syntactic awareness on reading accuracy and reading comprehension has been investigated in 8–and 10– year old children (Cain, 2007). Syntactic awareness was assessed by two tasks: word order correction and grammatical

correction. Overall, results showed that word-order correction was more dependent on memory skills while grammatical correction was more dependent on grammatical knowledge. With regard to syntactic awareness and reading comprehension, Cain reported that their relationship “was indirect and arises from the variance shared with vocabulary, grammatical knowledge, and memory” (p. 691).

As noted above, empirical evidence clearly shows the prominent roles that semantics and syntax play in reading acquisition and development. These components of spoken language skills contribute to reading and reading comprehension in typically achieving readers and also in populations with reading disabilities.

Relationships between orthographic awareness and reading. In addition to phonological awareness and naming speed, orthographic knowledge is essential for skilled reading (Barker, Torgesen, & Wagner, 1992; Berninger et al., 2010; Ehri, 1992; Nathan & Stanovich, 1991; Perfetti, 1992; Rahbari & Sénéchal, 2010; Seymour, 1997; Share, 1999). The standard definition of orthography is that it is a system of print symbols that represents spoken language (Chomsky, 1970; Venezky, 1999). Orthographic knowledge is usually defined as knowledge of letter strings and word-specific orthographic representation (Apel & Apel, 2011). In written language, orthographic processing is an integral component of reading and spelling. For example, orthographic regularities are believed to help students learn the correct spelling of morphologically complex words that vary in phonological form (e.g., muscle, and muscular; Chomsky, 1970). Orthographic knowledge is integral to all models of written language acquisition. For example, in the five phase model of reading acquisition, (Ehri, 1995; Ehri & McCormick, 1998) proposed that reading progresses in the following developmental stages: pre-alphabetic, partial alphabetic, full alphabetic, consolidated alphabetic and automatic alphabetic.

In this model, phonological awareness is seen as a critical skill in early reading development, while orthographic knowledge is the more important skill in later development. Ehri and McCormick (1998) explained that in early stages decoding is needed whereas in later stages more than decoding is needed to learn orthographic patterns. They posited that knowledge of letter chunks (roots and affixes) is necessary for the speed and accuracy of reading. Byrne, Fielding-Barnsley, Ashley, and Larsen (1997) found that knowing names of letters (letter knowledge) accounted for more variance in a decoding task in preschool and kindergarten children than did a measure of phonemic awareness. Hulme, Muter, and Snowling (1998) also suggested that letter knowledge upon entry to school is the best single predictor of word recognition. While Share (1995) argued that the phonological skills continue to be the most important skills throughout reading development, he underscores that orthographic knowledge is essential too. It is well acknowledged that knowledge of the letters and the spelling patterns within words play a fundamental role in reading an alphabetic orthography.

It should be noted that one of the common tasks in assessing orthographic knowledge is the orthographic choice task (Olson, Forsberg, Wise, & Rack., 1994). This task requires choosing the correct spelling of a word from pairs of phonologically matched words with only one spelling representing the correct written form of the word (e.g., hert vs. hurt). This task is clearly different from decoding because it requires recognition of the correct orthographic pattern rather than mapping graphemes onto their corresponding phonemes. Other types of orthographic awareness measures include Orthographic-Receptive Coding and Orthographic-Expressive Coding (Berninger et al., 2010). In the *Orthographic-Receptive Coding* task, the child makes a judgment about the identity and order of letters in briefly exposed written real words (e.g. word) or pseudowords (e.g. wirf), whether or not (a) the next word matches it exactly (e.g., werd or wirf),

(b) a given letter was in it (e.g. o or i), or (c) a given letter group was in it in exactly the same order (e.g., ow or ir). The *Orthographic-Expressive Coding* task requires the child to code written words or pseudowords into temporary memory and reproduce all or parts of them in writing. The task is then to reproduce (a) the whole word (worf), (b) a letter in a designated position (e.g., last), or (c) letters in a designated position. Measures of orthographic awareness that are distinct from phonological awareness highlight that the role and contribution of orthographic processing is unique and distinct from that of phonological or morphological awareness.

Roman et al. (2009) examined the degree to which the constructs of phonological awareness, morphological awareness, orthographic knowledge, and naming speed contributed independently to reading development. They assessed a sample of 99 children from Grades, 4, 6, and 8 on measures in each of these four constructs while reading words and pseudowords, and used multiple regression analyses to determine the unique contribution of each of the four constructs to real word reading and pseudoword reading. They found that children relied more on phonological awareness when reading pseudowords and more on orthographic knowledge when reading real words. This finding is consistent with Ehri's (1995) phase model of reading development which posits that both phonological and orthographic knowledge in addition to morphological awareness, in the consolidated phase, are core skills that underlie word-level reading. Furthermore, Roman et al. examined children's morphological awareness and found that its contribution to word reading is independent from the unique contribution of orthographic knowledge. Roman and her colleagues noted that orthographic knowledge is particularly important to reading beyond third grade when words with more complex morphological patterns (e.g., socialization, nationality) appear in all areas of the curriculum. Interestingly, Roman et al.

reported that orthographic knowledge was equally important to phonological awareness across the Grades 4, 6, and 8. Altogether, their results support that morphological awareness and orthographic awareness each exists as a separate construct from one another, and each of them contributes distinctly to word reading. Worth noting here is that orthographic awareness made a unique contribution to text-reading fluency, more than word-reading fluency, in Grade 3 English-speaking children (Barker et al., 1992). Kim (2015) also reported converging evidence from Korean children about the independent contribution of orthographic awareness to text-reading fluency after accounting for its contribution to word-reading fluency. Clearly, awareness of letter strings helps in reading connected text.

In a longitudinal study, Berninger, et al. (2010) studied the growth of three different kinds of linguistic awareness, phonological, orthographic, and morphological awareness of 241 children in two cohorts. They tested the first cohort in Grades 1, 2, 3, and 4, and the second cohort was tested in third, fourth, fifth, and sixth grades. Berninger et al. reported that: (a) with phonological awareness, most growth took place before- not after- third grade; (b) for orthographic awareness, growth occurred at a faster rate in the early elementary grades (1–3), and at a slower rate thereafter (4 – 6); and (c) for morphological awareness, results showed that although growth began in the first three grades, its developmental trajectory continued in the grades after and beyond. In fact, for the derivation task, which required generation of an affixed word from a base word, they found that it did not reach ceiling indicating that morphological awareness is a type of linguistic skill that continues to grow in the upper grades and beyond. Berninger et al. (2010) concluded by stating that phonological awareness alone is not sufficient for learning to read and write, and recommended that reading instruction should focus also on orthographic and morphological awareness. Their evidence-based finding of growth in the three

linguistic awareness kinds led Berninger et al. to recommend that teachers should coordinate between these three kinds of linguistic awareness in order to optimize learning of students.

Relationships between morphological awareness and reading. Recent research on reading in English has provided mounting evidence for the role of morphology in a variety of literacy skills (Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Nagy, Berninger, & Abbott, 2006; Kirby et al., 2012, Roman et al., 2009; Singson, Mahony, & Mann, 2000). Morphology refers to the aspect of language that deals with “word-formation processes, including inflections, derivations, and compounds” (Nagy, Carlisle, & Goodwin, 2014, p. 4). Morphology provides meaningful cues for the reader and the speller, because it allows learners to analyze unknown words into their constituent morphemes, and synthesize the morphemes into complex words. A morpheme is the smallest linguistic unit that carries meaning. For example, the word unbelievable is composed of three meaningful units, un + believ (e) + able, which are referred to as the “prefix”, base”, and “suffix”, respectively. Each of these units has a meaningful grammatical function. In contrast, a word like cable is composed of a single morpheme because it cannot be segmented into more than a single unit of meaning. This metalinguistic ability to analyze words into such meaningful units is commonly referred to as morphological awareness (MA). Carlisle (1995), a major contributor to our knowledge of this construct in reading acquisition defines MA as “awareness of morphemic structures of words and the ability to reflect on and manipulate that structure” (p. 194). The various tasks that have been used to assess MA are discussed in detail below.

As noted earlier, morphological awareness has been linked to a variety of literacy skills. The existing research on reading and morphological awareness have examined MA’s contribution to different component skills of reading such as reading accuracy, reading fluency,

reading comprehension, and vocabulary (Carlisle, 2000; Carlisle & Fleming, 2003; Deacon, Benere, & Pasquarella, 2013; Deacon & Kirby, 2004; Mahony et al., 2000; Nagy et al., 2006; Tong, Deacon, & Cain, 2014). Kirby et al. (2012) investigated the relationship between MA and reading development in Grades 1- 3. They measured children's morphological awareness in Grades 1, 2, and 3 and assessed multiple measures of reading, including: word reading, comprehension, accuracy, and fluency. After accounting for phonological awareness and intelligence, morphological awareness in Grade 3 was found to contribute to all five reading measures in Grade 3 more than for Grade 2, suggesting that morphological awareness in reading becomes more important once children are reading to learn. Roman et al. (2009) also provided evidence for the unique and constant contribution of morphological awareness to reading through Grade 8. Deacon and Kirby (2004) also provided evidence for morphological awareness above and beyond that of nonverbal intelligence. The role of morphological awareness was also shown to be independent of vocabulary (Fowler & Liberman, 1995; Mahony et al., 2000).

Although morphological awareness was alluded to in the several reading models, it was never a separate component or phase. For example, Ehri's developmental model noted above discussed the importance of letter chunks in enhancing decoding and fluency of reading. The explicit role of tying meaning to letter chunks was not central in the model. Similarly, in the "*triangle model*" of reading (Seidenberg & McClelland, 1989), morphology was not assigned a special cognitive system amongst the three proposed cognitive systems: phonological, orthographic, and semantic. Another example where morphology could have been given a special and more explicit place is in Perfetti's (2007) *lexical quality hypothesis*. Perfetti (2007) posited that that the quality of the lexical representations learners develop about words will affect the efficiency with which words are retrieved during reading. Perfetti identified four linguistic

constituents contributing to the quality of lexical items: phonology, orthography, grammar, and semantics. His fifth representational feature, constituent binding, refers to the degree to which the other constituents are integrated together. When all these constituents act in concert, it is easier for the reader to read smoothly and comprehend. Efficient retrieval of phonological and orthographic word identities allows for fluent reading. When the semantic constituent is binding with the other constituents, comprehension is achieved. Conversely, when these linguistic constituents are loosely connected or not well-specified, the reader will be at risk for decoding and comprehension difficulties, because the lexical quality of the words is poor. The lexical quality framework works for both, skilled and developing readers. Any of its constituents maybe compromised; for example, one may read with ease, but not understand the meaning. In this case, the semantic constituent is compromised. This integrative process of the word's phonological, orthographic, and semantic elements is at the heart of Ehri's (1978, 1992) amalgamation model of word-level reading. Ehri's conjoint theory in essence links phonology (sounds), orthography (spelling), and semantics (meaning) together.

Although morphology was not included as an independent constituent in the original accounts of the *lexical quality hypothesis*, Verhoeven and Perfetti (2011) acknowledged the role of morphology in decomposing polymorphemic words. They explained the role of morphology in enhancing the lexical quality of words, particularly complex words,

It can be assumed that the acquisition of reading requires multiple encounters with words that build up representations that reflect word familiarity and word knowledge, and that rare or orthographically complex forms often need to be identified via parsing or the segmentation of the word in its morphological constituents. Morphological decomposition can thus be seen as self-teaching device in reading complex words via

increasing lexical quality leading to instance-based learning of lexical items toward automatic recognition. (p. 461)

In fact, over the past 15 years an increasing number of empirical studies in alphabetic languages has shown unequivocally that morphological awareness plays a key role in reading development (Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Berninger et al., 2010; Kirby et al. 2012; Singson, Mahoney, & Mann, 2000) along with the more widely studied constructs of phonology, vocabulary, orthography, and rapid automatized naming (Carlisle, 2000; Deacon & Kirby, 2004; Kirby et al. 2012; Olson et al., 1994; Stahl, 1999; Torgesen et al., 1994; Wolf, 1991). As with the constructs of phonological awareness and orthographic knowledge, the literature on morphology and reading reveals different experimental methods being used to assess MA in children and students. The distinctions in these measures tap different skills.

Methodologies for Assessing Morphological Awareness

Morphological awareness has been assessed using a wide range of tasks across spoken and written language and that differ in complexity. Some tasks require composing words out of morphemes, whereas other tasks required decomposing a morphologically complex word into its constituent morphemes. Some tasks require an oral response, while other tasks require a written response. Morphological awareness tasks have been used most frequently to investigate its role in reading with children beginning at Grade 1 (Carlisle, 1995) through sixth grade (Mahony et al., 2000) and eighth grade (Roman et al., 2009) in both longitudinal and cross-sectional studies. For example, Carlisle (1995, 2000) developed two morphological tasks, one to examine derivational morphemic knowledge and one to examine the ability to decompose morphemes. For the derivation task, the child was given a base word (e.g. farm) and asked to change it for a specific syntactic context (e.g., The _____ plowed the fields). For the decomposition task,

the child was given a word with a suffix (e.g., dancer) and asked to shorten the word to make the base word fit a specific syntactic context (e.g., I like to _____). Carlisle (1995) followed kindergarten children through Grade 1 and reported that first graders did better than kindergartners on both the derivation and decomposition tasks. She reported that performance on these tasks in Grade 1 predicted word decoding and comprehension in Grade 2. Further, Carlisle (2000) showed that morphological awareness measured by derivation and decomposition predicted reading comprehension in Grades 3 and 5 children. However, she noted that the same tasks (derivation and decomposition) were more robust predictors of reading comprehension in fifth graders (accounting for 55% of the variance in comprehension) than third graders (accounting for 43% of the variance) because fifth graders have had more exposure to derived forms in print than third graders. Hence, fifth graders have had more opportunity to learn to use morphological decomposition than younger students.

Derwing (1976) assessed relational knowledge of morpheme families by using a semantic judgment task that required participants to judge if pairs of words were related semantically (e.g., builder and build; corn and corner) or not. Derwing found that morpheme recognition was strongly related to semantic similarity between the pair of words rather than phonetic similarity. In a study designed to examine changes in morphological knowledge, Tyler and Nagy (1989) used Derwing's semantic relatedness judgment task to assess relational knowledge of morphemes and derivational suffixes signifying a syntactic category (e.g., *-ize* morpheme denotes verb). They reported that children improved significantly from fourth to sixth grade. Relational knowledge developed before syntactic derivational knowledge and sixth graders continued to develop this level of skill through eighth grade. In another body of research, morphological awareness was also linked to spelling in English (Nunes, Braynt, & Bindman,

1997; 2006), and reading and spelling in French (Sénéchal, 2000; Sénéchal & Kearns, 2007). Nunes and colleagues reported a longitudinal predictor of reading and spelling. Furthermore, Nunes et al. (2006) reported findings from two large-scale longitudinal studies which showed that learning to read and write does affect knowledge of morphemes, and that this relationship between reading and writing and morphological knowledge is a two-way relationship with a causal connection.

Measuring root awareness is another type of morphological awareness task that is used to assess morphological knowledge in Semitic languages such as Hebrew and Arabic. Root awareness is included because words in Semitic morphology are formed by the process of combining the consonantal root with word patterns in a nonlinear system. From the same root, many words can be derived to share the main semantic content and consonantal root. Hence it is important to assess knowledge of the relationship between the words derived from the same root and the root. Further, understanding the meaning of words in Arabic depends on accessing their specific constituent morpheme- roots. For example, the following words (/dars/, /darasa/, /mudarris/ are all related to the root /drs/ (to study), whereas the word /sarada/ is not related to the root /drs/, because it is derived from a different root /srd/ (to narrate). Root awareness has been shown to correlate with reading, and was found to be deficient in children with reading disability in Hebrew (Ben-Dror, Bentin, & Frost, 1995; Levin, Ravid, & Rapaport, 1999; Schiff, & Ravid, 2007). Ravid and Malenky (2001) examined the development of morphological awareness in a developmental study of 100 Hebrew speakers ranging in age from 5.5 years to 27 years.

Participants were tested on two types of morphological processes: (a) nonlinear processes in the derivational domain of the consonantal root and affixed word patterns; and (b) the linear

process of stem and suffix in the inflectional domain. The participants' awareness of roots and word patterns was measured by using three tasks, one involved pseudowords and the other two included real words. In the first task, designed to assess root and pattern awareness, participants were asked to provide an answer to an open-ended question, for example, "Why is a *librarian* called this name"? A response was considered correct if the participant paid attention to the internal structure of the word and provided a word that shared the root with the stimulus (such as library). In the second task, designed to assess morphological awareness, analogies were used to assess root and pattern awareness indirectly. For example, the participants were asked to "Provide a semantically similar word to specific nouns such as "*writing*." Finally, in the third task, designed to assess root and pattern awareness, the authors presented participants with sentences containing nonsense words developed from a real root and a common pattern. Then participants were presented with two real words that may share either the root or the pattern with the nonsense word. Participants were asked to decide if each of the two given real words was related to the nonsense word or not. The authors' rationale for this task was that since nonsense words carry no meaning, the participants are forced to focus on nonsense word's root and pattern in isolation of meaning when judging if the nonsense words were related to the real words or not. Ravid and Malenky (2001) found that roots were easier to identify and manipulate than word patterns, especially among the young age groups. They concluded that the root (consonantal) is the most basic and salient constituent in Semitic Hebrew.

The literature on reading and its component processes is replete with various examples of MA tasks designed for Indo-European languages and other languages. Analyses of these MA tasks across languages underscores the various features of morphology that characterize this specific component of language. In this regard, Deacon, Parrila, and Kirby (2008) proposed a

taxonomy for describing various task features to consider when using MA tasks (see Table 3). These features include the degree to which MA tasks: (1) assess implicit or explicit knowledge; (2) require morphological production, composition, or judgment; (3) require oral or written answers; (4) involve stimuli at the word or sentence levels; (5) include inflections, derivations, or compounds; (6) manipulate phonological and orthographic shifts; and (7) engage short term memory.

In general, it is accurate to say that much of the research on MA and reading has treated MA as a unidimensional construct. Although a wide range of MA measures has been used across studies (Apel, Diehm, & Apel, 2013), only few studies (Muse, 2005; Spencer et al., 2015; Tighe & Schatschneider, 2015) have empirically tested the number of dimensions underlying a large number of different MA measures. To investigate the underlying nature of morphological knowledge, Muse (2005) administered nine different morphological knowledge measures along with three oral reading fluency tests, and two standardized vocabulary tests to a sample of fourth graders. The morphological knowledge measures varied on the following features: (1) oral vs. written modality of administration; (2) implicit versus explicit awareness and use of contextual clues; (3) multiple-choice versus production response format; and (4) type of task (identification, relatedness, structure & construction). Muse reported that the nine different morphological tasks measure the same construct. Further, Muse's findings showed that the correlation between morphological knowledge and vocabulary was high ($r = .91$), and these two constructs were inseparable for Grade 4 students. This finding can be explained in large part by the fact that vocabulary development encompasses knowledge of the morphological constituents of words (Carlisle, 2000; Tyler & Nagy, 1989). Muse also reported that when morphological knowledge

and vocabulary were combined, they accounted for a high degree of variance in reading comprehension.

In another study, but with adult participants, Tighe and Schatschneider (2015) administered seven different MA measures and two vocabulary measures (expressive and receptive) to 136 adult students. The first measure was the Base Form Morphology (BMORPH) Task, which required participants to decompose derivational target words into roots morpheme by filling in the blank with the root word (e.g., “Popularity. The girl wants to be ____.”; “Popular.”). Second, the Derived Form Morphology (DMORPH) Task was similar in format to the BMORPH task. In this task participants were required to derive a word from its root words (e.g., “Happy. Money does not buy ____.”; “Happiness.”). The third measure, Derivational Suffix Choice Test of Pseudowords, represented a pseudoword measure with context and included knowledge of derivational suffixes (The meeting was very ____,” the answer choices were lorialize, lorial, lorialism, and lorify). Fourth, the Morphological Skill Task assessed one’s ability to recognize morphological relatedness between derived and root words. Each participant was presented both visually and orally with morphologically complex derived words followed by three choices of root words. The participant was prompted to identify the correct root of the derived word. For example, a participant was provided with the word noncombatant and the three answer choices: comb, bat, and combat. Fifth, the Morphological Construction Task, measured an individual’s ability to manipulate syntactic information to construct new words. Each participant was presented both visually and orally with short scenarios, each of which contained a simple pseudoword and a blank. Based on the context of the scenario and the simple pseudoword, the participant was expected to utilize inflectional knowledge to fill in the blank with the correct pseudoword (e.g., “This is a musical instrument called a hux. Now we have three

of them. We have three ____.”; “Huxes.”). Sixth, the Morphological Analogy Real Word Task followed the format of A : B :: C : D. An example was “push : pushed :: lose : ____” = lost. Lastly the Morphological Analogy Task With Pseudowords followed the same A : B :: C : D format as the morphological analogy real-word task but included only pseudowords. Findings showed that MA was divided into two dimensions, one for real words and one for pseudowords. The dimensions of MA (real words vs. pseudowords) emerged as separate factors from vocabulary knowledge in the adult sample.

Spencer et al. (2015) reported on the unidimensionality of morphological awareness in two studies in which they assessed fourth- and eighth- grade students, using a variety of MA tasks and an expanded set of vocabulary measures for examining the breadth and depth of vocabulary knowledge. Spencer et al. (2015) found that a single-factor model of morphological knowledge and vocabulary emerged as the best fit model in both studies. The authors concluded that morphological awareness is an integral part of vocabulary knowledge and may even be considered an additional facet of an individual’s depth of vocabulary knowledge. Findings by Spencer and colleagues concord with Muse’s findings discussed above. However, these findings differ from findings by Tighe and Schatschneider who found that MA real-word and pseudoword measures appeared as separate dimensions, and also emerged as distinct factors from vocabulary among adult basic education students.

Previous studies suggest that the degree of unidimensionality of literacy constructs may change as readers become more proficient in reading leading different components of literacy to converge or diverge. For example, Nagy, Berninger, Abbott, Vaughn, and Vermeulen (2003) reported a strong correlation ($r = .78$) between morphological awareness and vocabulary even when phonological awareness and orthographic processing were taken into account. A similar

strong correlation ($r = .83$) was also found between MA and vocabulary for Grades 4 and 5 students (Nagy et al., 2006). Kirby et al. (2012) also found that MA and vocabulary become more related across grades. Moreover, as stated above in Berninger et al.'s (2010) investigation using growth curve analysis, most growth of MA occurs in first to third grade. Similarly, Apel et al. (2013) found that different morphological awareness tasks differentiated students by grade level and predicted different aspects of reading. They reported that an affix identification task for printed words predicted spelling performance more effectively than did reading skill in second grade students. Apel et al. explained this finding by noting that the affix identification task required students to access their conscious knowledge of orthographic representations, because the task assessed written morphology, that is, the way affixes attach to and modify base words. However, empirical evidence suggests that this strong link between morphological awareness and vocabulary becomes weaker or less pronounced over time (Deacon, 2013; Deacon, Kieffer, & Laroche, 2014). Spencer et al. (2015) explained that variability in results with morphological awareness and other literacy skills may be attributed to various factors, some of which could be an increased exposure to printed text, the degree of exposure to morphological instruction, and the amount of morphological problem solving students do as their vocabulary knowledge of derived words increases.

In the context of this study with a focus on morphological awareness, differentiating between implicit and explicit MA tasks is of critical consideration and requires that a clear distinction be made. Several decades ago, Berko (1958) developed a classic example of a test of implicit morphological knowledge referred to as the “Wug test.” For this experimental task, children were introduced to an amorphous figure labeled a “wug.” The experiment was designed to observe children’s knowledge of morphological inflections by asking them to inflect use the

word “Wug” in different contexts. For example, she showed the children a picture of a “Wug” and said “This is a wug. Here we have two of them. We now have two...?” Children who replied by saying “wugs” demonstrated that they have internalized knowledge of the plural morpheme. This type of tacit knowledge exemplifies the implicit nature of morphological knowledge as opposed to the explicit awareness of morphology. Similarly, children’s overgeneralizations of the –ed suffix to irregular past tense, such as **“goed”* or **“buyed”*, is another example of children’s unconscious knowledge of the morphology of their language (Nagy et al., 2014; Owens, 2001).

In contrast, the explicit nature of some MA tasks requires the person to think consciously about working out the task. For example, in the oral word analysis task, children are required to break the word into its constituent morphemes (e.g., /mudarrisu:n/ “teachers” can be broken down to /mudarris/ “teacher” which can be broken down to /darras/ “taught” which stems from the root /d-r-s/ “anything to do with teaching and studying.” This is particularly important because morphology is usually not taught explicitly in schools (Moats, 2009). Bowers et al. (2010) and Nagy et al. (2014) have pointed out that there seems to be a fine line between implicit and explicit knowledge on some MA tasks. For example, in the morphological decomposition task (Carlisle, 2000), the child is provided with a suffixed word (e.g., farmer) and asked to complete the sentence by decomposing the target word to fit the sentence (e.g., The plowed fields are on the _____). Such a task may be considered an implicit task, especially with the syntax aiding in deriving the target answer, but it could also require analysis of the stimulus at the explicit level.

The previously discussed studies on MA clearly reveal that this construct encompasses a wide variety of tasks that vary in different domains. Task type and features of the items

embedded in a task tap different skills. In addition, other factors that may influence results of the dimensionality of MA could include sample size, age of participants, and the specific linguistic characteristics-specifically morphology-of the language being examined. Clearly there is a need for more research on the dimensionality of morphological awareness/knowledge. Nonetheless, what is evident from the existing research is the need for more comprehensive assessments with multiple components and a wide range of item representations in order to yield more robust assessments of MA and vocabulary knowledge due to the multi-faceted nature of both. The following sections provide an introduction to the Arabic language and discussions of Arabic orthography and morphology.

Arabic Orthography

Arabic, like Hebrew, is a Semitic language. It contains 28 letters, it is written from right to left, and uses three long vowels (a:, u:, and i:) and three short vowels or diacritics (a, u, i). The long vowels are fully represented in the orthography. In contrast, the short vowels are optional. Accordingly, when Arabic words and texts are vowelized, as in children's books and religious texts, this is considered a shallow orthography. In shallow orthography, each word has one possible pronunciation. On the other hand, when Arabic words and texts appear without the diacritics, as in newspaper texts, it is considered a deep orthography, and the disappearance of diacritics allows for multiple pronunciations due to the homographic nature of Arabic orthography. This is equivalent to the pointed/unpointed (vowelized/unvowelized) scripts in Hebrew, which denotes the presence of the vowels as opposed to absence of vowels. The contribution of phonological information mediated by short vowels is crucial for the accuracy of reading words (Abu-Rabia, 1996, 1999; Abu-Rabia & Taha, 2004). Beginning readers and poor readers will not be able to read accurately or fluently if short vowels are removed. More skilled

readers, on the other hand, are expected to read without vowelization. However, since Arabic is highly homographic, skilled readers need to depend on strategies other than decoding to attain reading accuracy when text is not vowelized. Such strategies include relying on the syntactic and semantic context. An example of how homographic words read differently depending on the choice of vowels follows. The same three consonantal letters [s.l.m] can be read differently when different short vowels are added yielding the following possible readings /salima/ “was saved, /silm/ “peace”, /sal.lama/ “shake hands”, or /sul.lam/ “ladder.” If the word is not vowelized, then the reader must determine the correct meaning, from these four homographic possibilities, based on syntactic and semantic cues.

A description of Arabic without a mention of diglossia (Ferguson, 1959) would be incomplete. Diglossia is a linguistic phenomenon defined as the presence of a high and a low variety of a language, one for formal use in writing and some speech situations, and one for colloquial speech only. Literary Arabic or standard Arabic is used in writing and in formal speech, whereas spoken Arabic is used in daily conversations. While children are acquiring the local language of their community, they are learning a low variety (non-standard) in diglossic Arabic. As they start formal schooling, children begin to learn the standard formal variety, which is the language of books. While each country in the Arab world has its own distinguishing dialects, they all share the same standard language which is the only form that appears in writing. An example of the difference between standard Arabic and spoken Arabic is the word /na:fiḏah/ (window) which is said in some dialects as /shub.baak/ , or /Shib.ba:k/ , or /de.ree.sha/. For more examples, see Table 1, which illustrates differences between the different spoken dialects and the standard language.

Table 1

Examples of Modern Standard Arabic and Spoken Arabic

English	MSA	Jordanian dialect	Emirati dialect	Egyptian dialect	Part of speech
Man	radjul	zalameh	raj.ja:l	ra:gel	Noun
Eat	jaʔkulu	jokel	ja:kel	ja:kul	Verb
Mouth	fam	tum	θam	buʔ	Noun
Pen	qalam	galam	galam	ʔalam	Noun

Note. MSA: Modern Standard Arabic

The significant role oral language plays in reading development has been confirmed repeatedly (Cain & Oakhill, 2007; Goswami & Bryant 1990; Elwér et al., 2013; Nation & Snowling, 2004; Sénéchal, 2010; Sénéchal & Lever, 2014). In the case of Arabic, the difference between the standard form and the dialects has been referred to as the “linguistic distance” by Saiegh-Haddad (2003). In a series of studies, Saiegh-Haddad (2003, 2004, & 2005) reported that the linguistic distance between Modern Standard Arabic (MSA) and Spoken Arabic (SA) exists in all aspects of the language and especially in phonology. Examples of this phonological difference are /ðahab/ (gold) in MSA versus /dahab/ in SA and /θaʕlab/ (fox) in MSA versus /taʕlab/ in SA. The implication of this finding is that there is a mismatch between some standard phonemes and their spoken phonemes. Another example is the phoneme /q/ in MSA which is articulated as /ʔ/, or /g/, or /k/ in SA depending on which dialectal variation the speaker uses. The diglossic situation of Arabic language has been acknowledged by other researchers (Abu-Rabia, 2000; Ayari, 1996; Tibi & McLeod, 2014; Tibi, McLeod, & Joshi, 2013) who reported that children learn to read and write in MSA although they converse in SA.

In addition, the difference between MSA and SA exists at the morphological level due to the deletion of some morphemes in SA. For example, case markers for nouns and mood markers

for verbs characterize MSA but are dropped in certain SA dialects. For example, MSA words (akal-a; he ate), (lwalad-u; the boy), (tuffaha-tan; an apple) possess the inflectional morphemes /a/, /u/, and /tan/, respectively. In spoken language, the words are pronounced without the inflected morphemes (e.g. /akal/; he ate, /lwalad/; the boy and /tuffaha/; an apple) (Saiegh-Haddad, 2003). Another example of morphological difference between MSA and SA is dropping off the dual marker /a:n/ and replacing it with either the number “two” or the plural form in some spoken Arabic varieties. The following section provides a more detailed description on Arabic morphology.

Arabic Morphology

Arabic language combines both linear and nonlinear morphology (Boudelaa, 2014). In linear morphology, morphemes are added in sequence one after another as prefixes and/or suffixes preceding or following the base word (e.g., en+ act+ ment). In nonlinear morphology, the internal structure of the word changes as a result of combining the root with the word pattern (e.g., from the root “k.t.b”, different words can be derived by means of applying different vocalic word patterns such as “kita:b”, “ka:tib”, “ka:taba”, and “kutub”). Nonlinear morphology will be discussed further in the section on Arabic morphology. In spite of its rich morphological structure, very few studies have been conducted on relationships between morphological knowledge and reading skills in Arabic-speaking children (Abu-Rabia, 2002, 2007, 2012; Abu-Rabia & Shalhoub-Awwad 2004; Abu-Rabia, Share, & Mansour, 2003). Unfortunately, most available studies on children learning to read Arabic have either neglected to include the role of morphological awareness as a variable or have assessed only one type of morphological awareness task with few items in spite of the fact that Arabic combines different dimensions of morphology (e.g., linear-nonlinear & inflectional-derivational). An in-depth examination of

morphological awareness in native Arabic-speaking children is warranted given: (a) empirical evidence pointing to the significant role of morphological awareness in text-reading fluency and in reading comprehension in English and several other alphabetic orthographies; and (b) the centrality of morphology in the lexical architecture of Arabic, making this an ideal orthography for testing the contribution of morphological knowledge to reading.

The complexity of the Arabic language is reflected in its morphology. While Arabic morphology shares some similarities with other languages, the structural and derivational processes of its words are in sharp contrast with the morphology of Indo-European languages, such as English (Qasem & Foote, 2010; Boudelaa & Marslen-Wilson, 2001, 2005, 2015). However, similar to many languages, Arabic morphology is comprised of both inflectional and derivational structures. Inflectional morphology provides information about the grammatical functions of a word such as gender, number (singular, dual, and plural), person, and time. In Arabic, prefixes, suffixes, or both are added linearly to real words. Derivational morphology refers to the process by which new words are derived from the root. In Arabic this process is nonlinear, which is different from English, and will be explained below.

Similar to languages across the world, most words in Arabic are considered morphologically complex because each derived word is made up of at least two underlying morphemes. All Arabic words, excluding about 100 words usually referred to as primitive words (body parts and names of some animals) (Boudelaa & Marslen-Wilson, 2001), are made up of two abstract linguistic units (root and word pattern) that are affixed simultaneously. Arabic roots are exclusively consonantal, unlike English words, which always include a vowel. Arabic roots provide the general semantic field of the word (e.g., k.t.b), which when combined with a word pattern (e.g., a-a-a) yields a meaningful word (e.g., kataba) with a specific meaning and which

represents a specific grammatical category (“to write”, verb). In contrast, word patterns are made of both long and short vowels and some word patterns have a few consonants. An example of a consonant representing part of the word pattern, not the root, is the consonant /m/ that appears in the word pattern “maCCaCa” referring to a place as in the words /maktaba/ “library” or /madrasa/ “school.” Word patterns in Arabic provide the morpho-syntactic and phonological information of words (Holes, 2004). The representation of the word-pattern is always orthographically discontinuous, in vowelized and unvowelized Arabic, with the root consonants interleaved between the long vowel letters of the word-patterns. Unlike roots, the word patterns are only partially specified in the unvowelized Arabic opaque orthography due to the absence of the short vowels. Examples of Arabic derived words as a result of combining the roots with different word patterns are provided in Table 2.

Table 2

Examples of Roots and Productive Word Patterns

Examples	English root/base	Arabic root	Infinitive verb	Agentive noun	Passive adjective	Place	Causality verb
Study	“study”	d.r.s	darasa	da:ris	madru:s	madrasa	dar.rasa
Write	“write”	k.t.b	kataba	ka:tib	maktu:b	maktaba	kat.tab
Draw	“draw”	r.s.m	rasama	ra:sim	marsu:m	marsam	ras.sama

Both the root and the word pattern are abstract autonomous entities and do not occur as independent words. The combination of the root with the word pattern yields words that have different semantic and grammatical functions. For example, there are 15 verbal word patterns, each representing a specific type of verb (e.g., infinitive, passive, or causative). An example of each of these types of verbs can be derived from the three-consonantal root (d.r.s) as in /darasa/

“to study”, /durisa/ “was studied”, or /dar.rasa/ “to tutor”. There are also nine nominal word patterns which, when combined with roots, derive nouns such as the ones shown in Table 2.

Another example of different derivational processes can be seen in the root (k.t.b). When the root is affixed on different word patterns such as (Ca:CaC), or (CuCaCa), or (maCCaC), it will yield the following different but semantically related words: (/ka:tib/ meaning “writer” ; /kutiba/ meaning “was written”; and /maktab/ meaning “office”. These derivatives share the core meaning of the root (k-t-b), which is everything related to writing. On the other hand, when the same word pattern is combined with different roots, the result is different words with similar syntactic functions, but completely different meanings. For example, the word pattern (CaCaCa) has the grammatical function of the verb “to do”. When affixed to different roots such as /d.r.s/, /k.t.b/, or /r.s.m/, the result is /darasa/; /kataba/; or /rasama/, meaning “to study”, “to write”, and “to draw”, respectively. It has been reported that there are around 6000 roots in Modern Standard Arabic with family size (productivity) ranging from as low as 2-3 to as high as 40 words (Boudelaa & Marslen-Wilson, 2011). While there are more roots than word patterns, the productivity of word patterns is much higher (Boudelaa & Marslen-Wilson, 2010, 2011). Productivity is a term used interchangeably with “family size” referring to the frequency with which a particular morpheme is involved in the processes of word formation that share the same stem (Schreuder & Baayen, 1997).

Moreover, Arabic morphology allows for orthographic regularity, because of the recurrence of the root’s consonants in any of the words derived from that specific root. To illustrate this, Table 2 provides some of the derivatives of three roots. For each of these three roots, their corresponding derivatives will share with their respective root the same letters (consonants of the root). For example, any of the words derived from /k.t.b/ must have these

three consonants regardless of its meaning or morpho-syntactic function as shown in Table 2. This form of “ortho-morpho” regularity contrasts with other alphabetic languages such as English. For example, while in English, derivatives from the base “write” are possible (e.g., “**w**riter”, “**w**ritten” or **w**rote”); other words such as “library”, “author”, “book”, and few others will not share consonants from the base “write.” In Arabic, from the root “k.t.b.”, many words will be derived while maintaining in their morphological structure the same orthographic representation of the root, hence allowing for regularity of its orthographic representation. The redundancy of the roots’ consonants appearing in their derivatives allows for well-defined orthographic representations (Ehri, 1992; Perfetti, 1992; Rahbari & Sénéchal, 2010; Share, 1999), which could play a facilitative role in Arabic reading acquisition.

Another striking difference between Arabic derivational morphology and English is that in the latter, morphemes are added linearly to the base by means of adding a prefix (*un-*), a suffix (*-able*), or both in some cases (as in “*unbelievable*”). It is worth noting that this linear process preserves the integrity of the orthography. Arabic derivational morphology, unlike its inflectional morphology, follows a non-linear method when deriving words. Deriving words in Semitic languages (Arabic and Hebrew) requires a different process whereby word patterns are interleaved with the roots, which interrupts the sequence of the orthography. Recall /ka:tib/, /kataba/, and /maktab/ which are all derived from the same three consonantal root /k.t.b/. In all of these examples, the root’s three consonants /k.t.b/ remain in the same order in spite of being interrupted by the vowels of the word pattern. Changing the order of the root’s consonants in the word /kataba/ “to write” will yield a totally different word (e.g., /kabata/ “to suppress”) or in some cases result in a pseudoword as in /takaba/.

Given that Arabic morphology is both linear and nonlinear and that word meanings and syntactic functions are derived from applying different word patterns onto different roots, the interlocutors and readers of Arabic are required to compose and decompose words and morphemes, influencing automaticity when speaking and comprehending (Boudelaa, 2014). Boudelaa and Marslen-Wilson (2005, 2011, & 2015) have provided empirical evidence showing that adult readers of Arabic place greater emphasis on root identification over word pattern while engaged in tasks of rapid word recognition. They designed masked and cross-modal priming experiments in which adults were required to decide as quickly and accurately as possible whether each string was an Arabic word or not. The researchers probed the processing relationship between roots and word patterns during a word recognition task and co-varied word pattern and root productivity in a 2 x 2 design. Participants were presented with 24 targets paired with a related prime in the first list and were paired with an unrelated prime in the second and vice versa. Targets and primes varied in the productivity range of the roots and word patterns (productive and unproductive) representing different conditions. The researchers reported that priming was determined entirely by the productivity of the root. Even very productive word patterns did not prime, if they appeared in the context of an unproductive root. The primacy of the root identification, over word pattern identification, remained the same in all priming experiments regardless of variations in productivity of the roots. Conversely, word pattern priming seemed to be dependent on the productivity (family size) of the root with which it co-occurred, rather than the productivity of the word pattern by itself. They also found that the primacy of the root was comparable under both visual and auditory processing conditions.

Findings of this nature have implications for the importance of decomposing words to identify the roots while quickly reading Arabic words by adult readers, yet little is known about

the development of these word decomposing processes in children during stages of reading acquisition. If identification of the root occurs prior to word patterns in word recognition tasks, we would expect to see evidence of this in the error patterns made during children's development of word recognition. Specifically, we expect to observe a higher rate of errors associated with suffixes, prefixes, and parts of word patterns rather than with the consonants in the words' roots. This remains to be investigated, especially in Arabic-speaking children during the primary stages of language acquisition. Recall roots are fully specified consonants, whereas word patterns are partially specified, especially in the unvowelized texts when short vowels are not added.

Review of the Arabic Literature

There is a dearth of research on native Arabic-speaking children learning to read. The few studies to date lack standardized measures because such data do not yet exist. Furthermore, previous studies failed to take into account the frequency count of Arabic words and all test designs were adapted or translated from other languages, mainly English. None of the existing studies on Arabic reading development or reading disabilities employed a longitudinal or intervention design. Other limitations noticed included: small sample sizes, the population from which the sample was drawn, choice of variables, and applicability to younger native Arabic-speaking children. In spite of all the weaknesses, it is important to review the existing literature to inform future research. Since the available literature on Arabic reading and morphological awareness is limited, I will also review two studies that included Arabic-English bilingual speakers living in North America. Farran, Bingham, and Mathews (2012) examined the relationship between components of language (i.e., phonology, morphology, and vocabulary) and different reading outcomes (vowelized and unvowelized words, pseudowords, complex word reading fluency, and comprehension) in 83 10-year-old bilingual English-Arabic children. Their

results revealed partial positive correlations ($r = .43-.47, p < .001$) between phonological awareness skills across English and Arabic, but no correlations between morphological awareness skills of Arabic and English ($r = -.04, p > .05$). Farran et al. argued that this lack of association was due to the different morphological structures of the languages. Results also revealed that: (a) for Arabic and English speaking children, phonological awareness predicted word and pseudoword reading accuracy of both vowelized and unvowelized words, and vocabulary predicted reading comprehension; (b) for Arabic-speaking children, both phonological awareness and morphological awareness explained 67% of the variance in word reading fluency of complex words, while only age contributing significantly to reading comprehension of Arabic children; and (c) for English-speaking children, chronological age and morphological awareness explained unique variance in reading comprehension

In order to investigate if morphological awareness uniquely contributed to children's reading comprehension scores above and beyond children's grade, phonological awareness, and vocabulary, Farran et al. (2012) used a series of hierarchical regression analyses and found that neither phonological nor morphological awareness predicted reading comprehension in Arabic. They attributed this result to children's lack of proficiency and limited vocabulary in Arabic, due to the fact that the participants' first language was mostly English. Unlike morphological awareness, vocabulary predicted reading comprehension within Arabic and English which is in accordance with cross-linguistic studies showing the role of vocabulary in reading comprehension (Cain & Oakhill, 2007; de Jong & Van der Leij, 1999).

The diminished role of morphology in comprehension could be due to limited vocabulary, but it also could be attributed to the design of the morphological task they used and its reduced variability. Considering the different morphological structures and their grammatical

functions is essential when designing any morphological task. The variety of word patterns, grammatical categories, derivational versus inflectional morphology, degree of phonological and orthographic shifts, all when combined constitute an integral part of any Arabic morphology task. Unfortunately, the only MA task included in Farran et al.'s (2012) study was taken from Saiegh-Haddad and Geva's (2008) study and comprised of only 20 items that were phonologically transparent, covered only four word patterns, and required a yes/no answer. Such a task could not have accounted for the wide range of Arabic morphology; hence it is a methodological concern that could have affected the results on the role of MA in reading Arabic. Moreover, other Arabic cognitive variables, such as rapid naming speed, could have been included in order to understand more specifically the processes that take place in reading Arabic as a first language, without the possible influence of cross-linguistic transfer.

In contrast to Farran et al.'s (2012) finding on MA, Abu-Rabia (2007) compared typically developing and dyslexic Arabic-speaking students in Grades 3, 6, 9, and 12 and found that, within groups and at all grade levels, performance on an orthographic morphology task was a robust, and often sole predictor of word recognition accuracy and reading comprehension in vowelized texts. In a previous study, Abu-Rabia et al., (2003) compared reading-disabled (RD) and normal readers of the same chronological age (9.5-10.5 years), and in younger normal readers (7.5-8.5 years) at the same reading level. They found that the reading-disabled children performed poorly on the morphological measures, and their overall performance was significantly poorer than that of the other groups. After phonological awareness, morphology was the second strongest predictor. Differences between Abu-Rabia's study (2007) study and Farran's could be due to bilingualism as was the case in Farran's study.

Saiegh-Haddad (2005) examined the contributions of phonological awareness, rapid automatized naming (RAN), and phonological memory (PM) to letter recoding speed and pseudoword decoding fluency in 42 Arabic-speaking first graders. She found that PA only indirectly predicted fluency through its influence on letter recoding speed. One of the key findings in this study was that letter recoding speed and accuracy was the strongest predictor of reading fluency of vowelized Arabic. When the influence of letter recoding speed was controlled, PM was the strongest predictor of reading fluency, followed by RAN. Obviously the speed of converting graphemes into phonemes stood out as the primary predictor of reading fluency among first graders despite the diglossic effect. In a cross sectional study of 171 Arabic-speaking children from Grades 1-3 in Bahrain, Al-Mannai and Everatt (2005) reported that measures of PA predicted real word reading and spelling amongst young Arabic learners. Children were tested on numerous measures including single word reading, pseudoword reading, spelling, phonological awareness, short-term memory, speed of processing, and non-verbal ability. The authors found that phonological skills measured by pseudoword decoding and PA tasks were the best predictors of reading and spelling. As noted in previous studies, these authors also found differences in predictors between Grade 1 children and Grade 3 children. For the younger children, pseudoword reading was a stronger predictor of reading and spelling whereas word recognition was a stronger predictor of reading and spelling in the older children.

In a cross-sectional study, Taibah and Haynes (2011) investigated the correlational and predictive relationship between different phonological processing abilities and early reading development amongst 237 Arabic-speaking children from K-3. The researchers investigated whether the powers of PA, RAN, and phonological memory in predicting reading abilities vary as a function of grade. The variables of interest included: PA (elision and blending), RAN

(object, color, letter, and digit), and phonological memory (pseudoword repetition and digit span), and their contribution to basic decoding and fluency skills in Arabic measured by word decoding, pseudoword reading fluency, and retell fluency. Using a set of regression analyses, the researchers found that after PA was entered, RAN was left to explain a small but significant amount of variance that increased with age. Further, RAN's capacity to predict word recognition, pseudoword reading fluency, and oral reading fluency was most evident in the third graders' reading performance. In another set of regression analyses, the researchers entered RAN as the second variable followed by PA (after controlling for gender, language exposure, and cognitive ability). Taibah and Haynes reported that when word recognition or pseudoword reading fluency were the outcome variables, the predictive power of RAN increased by grade and explained more variance than PA by Grade 3. In kindergarten and Grade 1, PA accounted for more variances in these word-level outcomes than did by RAN.

In summary, PA proved to be a significant predictor of unique variance in all of the reading outcomes-recognition, decoding, fluency, or comprehension. When children read lists of words, whether real or pseudowords, the predictive power of PA was highest in the early grades, decreased in second, but caught up again by Grade 3. However, reading text showed different results with PA contributing greater variance in early grades while RAN contributed greater variance in later grades. These results were also supported when RAN was entered before PA; that is, PA still explained significantly high amounts of variance that were not explained by RAN in first and second grades; however, the predictive power of RAN increased by third grade and exceeded PA's predictive power which is in accordance with findings reported by Kirby et al. (2003).

While overall PA accounted for more variance than RAN across reading outcome measures in Taibah and Haynes' research, this finding might be expected given the nature of the stimuli used in their study. Their reading outcome measures depended more on decoding than fluency, especially in the oral reading fluency measure where vowelized texts were used that require phonological processing. Even when they measured pseudoword fluency, this type of test requires decoding because pseudowords cannot be read as sight vocabulary. Had they used unvowelized texts as an outcome measure of oral reading fluency, their findings might have been more consistent with those reported by Kirby et al. in which RAN contributed greater variance than PA in text reading. Finally, in this study, no measures of morphological awareness were included precluding insight into the possible role of morphology in the presence of phonological awareness.

In another cross-sectional study that used students from a wider range of grade levels, Asaad and Eviatar (2014) assessed the relative role of phonological awareness, letter knowledge, and visual abilities in predicting reading accuracy and speed in Arabic, at different skill levels. Participants in this study included 31 first graders, 30 third graders, and 35 fifth graders, who were native Arabic-speakers. Overall, they found that phonological awareness affected reading accuracy at all levels, and that access to letter names (i.e., RAN) affected reading speed in first and fifth grade. Also, they found a significant interaction between PA and grade level for reading speed scores. In first and fifth grade, the relationship between PA and text reading speed was not significant, however, in third grade, the relationship between reading speed and PA was strong and significant. However, the correlation between letter naming speed and reading speed was significant and strong in first and fifth graders, but not for the third graders.

Asaad and Eviatar (2014) found that visual-perceptual abilities were not related to the reading measures, but were positively related to phonological abilities in all grades. The authors agreed with the hypothesis that the visual complexity of Arabic orthography does affect its processing indirectly, which is in accordance with previous research that has shown Arabic letter identification requires much longer exposure durations in Arabic than in Hebrew or in English (Abdelhadi, Ibrahim, & Eviatar, 2011; Eviatar & Ibrahim, 2004).

In a cross-sectional study of first, third, and fifth grade Arabic students, Asaad and Eviatar (2014) investigated the contribution of letter names and phonological awareness to text reading speed and accuracy. While they found that phonological awareness contributed most strongly to text reading accuracy across all grades, they observed that rapid letter naming's contributions across grades was less robust. Asaad and Eviatar suggest that the less robust impact of rapid letter naming across grades may have been related to the children's varying levels of reading skill. For example, representations of letter names may not be well established in Grade 1 children whose reading is largely reliant on sound-letter decoding whereas letter names should be fully automatized by Grade 5 when children are likely to be using more sight-word reading strategies based on orthographic patterns rather than individual letters.

Perhaps a detailed analysis of the different reading texts presented to Grade 1 (41 vowelized words) and Grade 3 (141 vowelized words) might reveal other reasons for the findings. A closer look at the texts (see appendix of Asaad & Eviatar, 2014) revealed that four words in the first grade text are repeated 3-4 times each. It could be argued that reading each of these words on the first exposure sped up reading of the same words when encountered again. Another issue for orthography overriding phonology at this stage might be the fact that some words were only partially vowelized. One may wonder if all the words were entirely vowelized,

would there be a different finding in favor of PA at this grade (Grade 1). Unfortunately, this study lacked measures of orthographic processing (choosing the correct spelling from two phonologically similar words) and morphological awareness (e.g., word analogy or decomposition or deriving a word from a given root). Measures of these constructs could have informed us about their contribution to reading (fluency and accuracy) for each grade level.

Elbeheri, Everatt, Mahfoudi, Abu Al-Diyar, and Taibah (2011) reported on the significant effect of orthographic processing in reading comprehension fluency of mainstream Arabic-speaking children (Grades 2-5) and children with learning disabilities (Grades 3-5) attending special education schools with small class sizes. Participants in this study were administered measures of reading comprehension fluency (choosing the correct word from choice of four words to complete the meaning of 50 incomplete sentences in a time limit of 3 minutes), two orthographic discrimination tests (50 pairs of words and 50 pairs of non-words where participants were required to choosing identical spelling from pairs of words in 60 seconds), phonological processing (decoding and awareness), speed of processing (object naming and letter naming), and memory (visual and verbal).

Elbeheri et al. (2011) found that orthographic processing predicted variability in comprehension fluency over-and-above that predicted by the other measures in the study when controlling for phonological processing. This finding was significant amongst Grades 4 and 5 mainstream students and among the learning disability group (Grades 3-5), but was not found in the younger students (Grades 2 and 3) where text was vowelized. Similar findings with LD children have been reported in other studies (Abu-Rabia et al., 2003; Al-Mannai & Everatt, 2005; Elbeheri & Everatt, 2007) in which the researchers noted that the LD children showed an influence of orthographic processing independent of phonological processing despite being

diagnosed with learning disabilities. If this is the case, LD children may be applying different strategies, such as reading words as a whole without full phonological processing which could impair their reading accuracy. Most likely, if LD children lack phonological processing, then the homographic words (words written with the same graphemes- mainly consonants) but can be read differently when vowelized with different vowels (e.g., /k.t.b/ can be read as an active verb /kataba/ or as a passive participle /kutiba/) are read inaccurately, particularly when such words appear in unvowelized texts. Hence, unvowelized homographs may pose a challenge for individuals with LD who have deficits in phonological processing. Issues of this nature call for a thorough investigation of morphological awareness in children with deficits in phonological processing, particularly root awareness, using MA tasks in varying syntactic contexts. A brief review of the research focusing on the impact of diglossia on phonological processing and reading of Arabic follows.

Diglossia as explained earlier as a sociolinguistic phenomenon, refers to coexisting varieties of the same language. For example, Arabic has the standard literary language and in addition to a number of different spoken dialects. In the Arabic language, the classical form or literary Arabic is used in more formal communications such as books, religious practices and in the media, whereas the less formal use of the language, referred to as colloquial or dialectal, is used in daily conversations. It has been documented that there is a linguistic distance between the literary Arabic and the spoken dialects at the lexical, phonological and morphological levels (Maamouri, 1998; Saiegh-Haddad, 2003).

In her 2004 study, Saiegh-Haddad tested the effect of the phonological and lexical distance between Modern Standard Arabic (MSA) and Spoken Arabic (SA) on children's PA. She investigated whether the lexical status of the word (SA, MSA, or pseudo) affected children's

ability to access phonemes in SA versus MSA phonemes. As noted previously, some MSA phonemes are pronounced differently in SA depending on which dialect a person speaks, as in the example of /q/ pronounced as /q/ in MSA, but as /ʔ/, or /k/, or /g/ depending on one's dialect. Her results showed that, although MSA phonemes were more difficult to access than SA phonemes, MSA phonemes embedded within MSA words were more difficult than those embedded within pseudowords. Saiegh-Haddad concluded that this finding was due to the inaccurate phonological representation for MSA phonemes and MSA lexical items, and also due to the interference of the spoken representations for these standard structures. In fact, several researchers postulated that low-quality phonological representations yield impoverished phoneme awareness which has a negative impact on skilled reading. (Elbro, 1998, 1999; Elbro et al., 1998; Perfetti, 1985).

In a later study, Saiegh-Haddad (2005) investigated the role of cognitive and phonological processes in pseudoword reading fluency in a sample of 42 Grade 1 Arabic students. The cognitive measures included RAN and short-term working memory tasks. In addition, children were assessed on two phonological skills: phoneme discrimination of pairs of consonants, and phoneme isolation in pseudowords. Participants listened to orally presented pseudoword stimuli and were then asked to identify the first phoneme. Orthography was assessed by means of letter-phoneme recoding speed for which participants were required to sound out a random list of 50 letters in one minute. The dependent measure in this study was pseudoword reading fluency which consisted of a randomly ordered list of 20 vowelized pseudowords: 10 words that were composed of SA phonemes only and 10 words that encoded one MSA phoneme in an initial or a final position.

Saiegh-Haddad reported that all predictor measures, except phoneme discrimination, correlated with pseudoword reading fluency. Stepwise regression analysis showed that the strongest predictor of pseudoword reading fluency was letter recoding speed (the speed of naming letter names or sounds). Letter recoding speed was predicted by memory, rapid naming, and phoneme isolation. Also, Saiegh-Haddad reported that a moderate correlation between phoneme isolation and reading fluency disappeared when rapid naming, or letter recoding speed, along with memory, were used in the regression analysis. Accordingly, Saiegh-Haddad (2005) argued that because phonemic awareness is acquired easily in a shallow orthography, rapid naming speed, letter-sound recoding speed, and memory could be the salient factors underpinning reading fluency of Arabic-speaking children at the end of their first year of formal schooling. While Saiegh-Haddad's finding contradicts Taibah and Hanes's (2012) finding discussed above in which the latter researchers confirmed the power of PA over RAN, particularly in the early Grades, Saiegh-Haddad's data are consistent with other researchers' findings in shallow orthographies (de Jong & van der Leij, 1999; Landerl & Wimmer, 2000; Wimmer et al., 1998, 2000) that have shown a diminishing effect of phonemic awareness in predicting reading fluency.

However, it is important to note that it is difficult to draw clear conclusions from Saiegh-Haddad's (2005) study for a number of reasons: the size of the sample was small ($n = 42$), the phoneme discrimination test had a ceiling effect, and scored the phoneme isolation as zero when the participants provided the correct response for the target phoneme but in a CV (consonant-vowel) syllabic unit, although Arabic language is known for the strong cohesion of its CV unit when in the initial position (Saiegh-Haddad, 2007; Tibi, 2010; Tibi et al., 2013). Furthermore, it would have been of value if Saiegh-Haddad included other types of reading measures such as

connected reading texts, real word reading, and/or pseudoword reading accuracy-without fluency- to compare/contrast the contribution of the same predictors to different reading constructs.

Moreover, although Saiegh-Haddad reported a significant contribution of working memory in pseudoword reading fluency, other researchers reported a diminishing effect for the role of working memory in reading (Abu Ahmed, Ibrahim, & Share, 2013). In their longitudinal study (KG-Grade 2), Abu Ahmed et al. reported that phonemic awareness was the strongest predictor of reading vowelized Arabic among Grade 2 children. Other “intra-lexical” predictors which were reported to contribute to word recognition were phonological processing (RAN and pseudoword repetition) followed by morphological awareness, and visual orthographic processing. It should be noted here that in Abu Ahmed et al.’s study, they used only one measure of MA, and it assessed only inflectional morphology and was administered orally in spoken dialect. The authors recognized this limitation and called for assessment of derivational morphology in future studies.

Smythe et al. (2008) investigated the contribution of several cognitive factors to both word reading and spelling skills amongst 107 Arabic-speaking third graders. They conducted a series of regression analyses with word reading and word spelling as the outcome variables and entered the potential predictor variables (visual processing, auditory processing, PA, verbal memory, and RAN) in an a priori sequence. Visual processing, measured by recall of sequences of abstract shapes, was entered first followed by a sound discrimination measure of auditory processing. Once variability was explained based on these measures, the measures of phonological processing, which included tasks that assessed PA (alliteration and rhyme), verbal memory (digit span), and the RAN (object and digit naming), were entered into the regression.

The phonological decoding task (untimed non-word reading) was entered last in the sequence. Findings indicated that measures of decoding and phonological processing skills (alliteration and rhyme) were good predictors of vowelized word reading and spelling among Arabic-speaking children. It is worth noting that this study did not include any measures of text reading or morphology and all word stimuli were vowelized and read without time constraints. It is quite possible that the authors' findings would change if reading fluency were included because it would provide a measure of processing speed. Regarding their findings on the role of phonological processing and decoding in vowelized word reading, this is in accordance with the studies reviewed above (Asaad & Eviatar, 2014; Farran et al., 2012; Saiegh-Haddad & Geva, 2008). Although the short vowels in Arabic appear in the vowelized script, Arabic reading does not depend entirely on the presence or absence of the vowels. Syntax, semantics, and morphology play important roles in reading accurately and fluently. For example, the morphological structure of Arabic is essential in forming its lexicon. Therefore, awareness of Arabic roots and the word patterns, allows for understanding of the derivational processes in word formation. Such awareness will facilitate reading accuracy and comprehension of words when vowels are absent as in the case of unvowelized orthography. Hence, in the case of unvowelized orthography, knowledge of Arabic morphology can be a facilitating agent in reading accuracy and comprehension. In addition, the semantic context aids in reading homographic unvowelized words accurately. Yet this is not to suggest that phonology plays a marginal role in reading accuracy in Arabic. The empirical studies discussed above all point to the importance of phonology for reading accuracy, especially in the early stages of reading development.

Finally, Arabic researchers have begun to examine the role of morphology in spelling. Saiegh-Haddad (2013) debated earlier findings reported by Abu-Rabia and colleagues (Abu-Rabia & Taha, 2004, 2006; Abu-Rabia & Sammour, 2013) that spelling errors in Arabic are due to phonological difficulties alone. Saiegh-Haddad found that Arabic-speaking students in first grade made use of morphological knowledge while doing a spelling task, especially when the words lacked grapheme-phoneme correspondences. For example, children were able to spell the letter <t> more accurately when it was part of the root as opposed to when <t> was represented in a word pattern (e.g., present tense prefix). Saiegh-Haddad (2013) explained that the root is more salient and more accessible in spelling than the word-pattern because of the orthographic representation of the roots, unlike word-patterns, are fully represented and sequential in vowelized and unvowelized Arabic.

Limitations of previous studies. As noted in the review of the Arabic literature on reading correlates, the vast majority of studies on the role of component dimensions of language that impact reading performance focused on variables that represent some form of phonological processing including phonological awareness and phonological memory. Far fewer studies have examined the role of morphology in Arabic readers and even fewer have investigated morphological knowledge and relationships between linguistic and cognitive factors and reading ability in Arabic-speaking children. Given the complex role that morphology plays in Arabic, where the use of morphology differs to some degree in literary (standard) versus spoken language and where morphological structures are essential for composing and decomposing Arabic words in print, studying the potentially unique contributions of morphology and other components of reading in Arabic-speaking children has the potential to contribute greatly to our knowledge of reading development in this Semitic language. Indeed, root and word-pattern

morphological processing have been shown to be a factor in word reading, reading disability (Abu-Rabia et al., 2003; Abu-Rabia, 2007; Abu-Rabia & Shalhoub-Awwad, 2004), acquired reading disorder (Prunet, Beland, & Idrissi 2000), and spelling (Saiegh-Haddad, 2013) in the Arabic speakers.

Chapter 3

Method

This chapter is divided into different sections to represent the two phases that were undertaken for the purpose of this study. Phase I addresses the first research question related to the dimensionality of morphological awareness as a construct and its ability to predict reading in Arabic. Therefore, there was a need first to develop 10 authentic Arabic MA measures and two reading measures (word and pseudoword reading), and field test these measures in order to validate them and examine the degree to which these MA measures are related to reading in Arabic. The 10 MA measures and the two reading measures were tested with a sample of 102 native Arabic-speaking Grade 3 participants who were recruited from public schools in the Emirate of Abu Dhabi, United Arab Emirates (UAE).

Phase II addresses the second and third research questions which aim at (a) examining the joint and unique contributions of the standard linguistic and cognitive predictors to different components of reading in Arabic; and (b) investigating the construct of reading in Arabic; that is, whether the five reading measures developed in this study are distinct from one another or not. Therefore, the following measures were developed: three additional reading measures (word-reading fluency, text-reading fluency, and reading comprehension), three measures of phonological awareness, two measures of orthographic processing, in addition to translating and adapting the PPVT vocabulary test, the two CTOPP digit span memory tests, and the two Rapid Automatized naming speed measures (object and digit naming). All these new experimental measures in addition to the previously piloted two reading measures and some of the piloted MA measures (four plus a newly developed MA measure-root awareness) were administered to a

second sample of 201 Arabic speaking Grade 3 children who were recruited from public schools in the Emirate of Dubai.

First, a description of *Phase I* method will be provided, and will include the following sections: participants, procedure, the rationale for developing the MA measures, a description of each of the 10 MA measures, a description of the two reading measures, and data analysis for Phase I. Second, a description of Phase II method will be provided, and will include the following sections: participants, procedure, experimental measures, and data analysis.

Phase I (Pilot Study): Investigating the dimensionality of MA in Arabic and its relationship with reading

Participants. After obtaining Queen's University Ethics clearance (see Appendix A) and the approval of Abu-Dhabi Educational Council, 102 Arabic speaking children were recruited from three public schools in the Emirate of Abu Dhabi to participate in the pilot study. It should be noted here that only Emirati nationals attend the public school system. In all public schools in the UAE, the school principal, vice principal and the majority of the teachers are UAE nationals who speak the Emirati dialect. All children who participated in this study were enrolled in Grade 3 (mean age = 104 months; SD = 5.76). Only the children with parental consent and child assent were tested (see Appendix A for Parent Letter of Information and Parent Consent form). The average participation rate was 60%. An equal number of girls (51) and boys (51) with a mean age of 104 months (SD = 5.7 months) were tested at the end of Grade 3. All children included in this pilot study were native Arabic speaking Emirati children with parents who were native speakers of Arabic. All children were learning Standard Arabic as a core subject in their curriculum.

Procedure. Children completed the 10 MA tasks and two reading tests (word reading and pseudowords). All tests were administered individually by the author, who is a native speaker of

Arabic, in a quiet room in the children's school. Children were tested in two 30-minute sessions and the order of tests given was consistent for each child. The first session included the word reading test and the six oral MA tests. The second session included the pseudoword reading test and the four written MA tests. For the written tests, children were instructed to read the sentences presented in print carefully and were given a pencil to use for writing or circling the correct choice. All tests were preceded by practice items (4 practice items for MA tests and 3 practice items for reading measures) to ensure that children understood task demands. Children were given corrective feedback if needed after each practice item. All instructions were given in the Emirati dialect, which was the children's spoken dialect.

MA measures. As noted in Chapter 1, Deacon et al. (2008) developed a taxonomy to delineate the different types of morphological awareness tasks according to modality, content, and process. This taxonomy, shown in Table 3, provides an excellent framework for studying morphology across languages because all MA tasks employed in the literature can be described based on the input-output type of stimulus, its content (inflectional and/or derivational), and whether the process requires composition, judgment or decomposition. This taxonomy can be applied to any language regardless of its type of orthography or morphology. In keeping with Deacon et al.'s taxonomy presented in Table 3, 10 Arabic morphological awareness tasks were developed to represent the various dimensions of morphology. It is worth noting that there were no validated measures of MA in Arabic at the time that the present study took place. Hence there is a need for developing authentic Arabic MA tasks. These tasks were designed to measure both oral and written language. The oral tasks required students to produce an oral response to an oral stimulus (e.g., if I say *car* and then I say *cars*; then I say *bag*, then you should say...?). Due to the occurrence of diglossia in Arabic speakers, it was deemed important to include one oral MA

task that tapped into spoken Arabic. The written MA tasks required students to read a sentence and then produce a written output (e.g., teach: I met the _____ at school), or place a circle around the correct choice (e.g., The “magic, magician, magical” was so good). Further, MA measures were designed to assess knowledge at both the word-level (e.g., walk-walked, dance, _____) and at the sentence level (e.g., I read a book: I read two books; We read a story: _____). Critical to this study, the morphological structure of Arabic (e.g., root versus word pattern) was taken into consideration when designing the tasks; thus a range of Arabic consonantal roots and word patterns that represent a range of grammatical functions were included in the task stimuli.

Table 3

MA Tasks based on Deacon et al. (2008) Taxonomy

		Oral	Written
Composition	Explicit	Word Analogy- Standard Word Analogy- Local Sentence Analogy	Morphological composition
	Implicit	Morphological relation judgment	Sentence Selection Sentence Completion
Decomposition	Explicit	Word Analogy- Standard Word Analogy- Local Sentence Analogy Word Analysis	Morphological Production through Decomposition
	Implicit	Morphological Relation Judgment	Sentence Selection

The 10 Arabic MA tasks developed for the purpose of this study included both written and oral tasks. Four of the tasks were presented in vowelized print and required the participants to read and write or circle the correct answer. The other six MA tasks were presented orally and

required the child to either provide an oral answer or to say *Yes* or *No*. All MA tasks included 20 items each. The termination rule for each MA task was four consecutive errors. Items within tests varied in the degrees of transparency/opacity of phonology, orthography, and semantics. In all multiple-choice tasks, the position of correct answers was varied randomly. The 10 MA tasks described in detail in the following section beginning with the written tasks and followed by the oral tasks. Also, an overview of these tasks appears in Appendix B.

MA task 1 (written): sentence selection. Participants were presented with 20 written vowelized incomplete sentences and asked to complete each sentence by circling the appropriate word from four alternatives. The four word choices for each item contained the target word plus distractors that were morphologically related, orthographically similar, or phonologically similar to the target, but incorrect. A typical item was, “In the summer, the weather is usually_____.” The four choices were: Ha:r, Hur, Hari:r, Hararah, meaning *hot*, *free*, *silk*, and *heat*. The participant’s score was the number of items correct. This task is based on the research of Singson et al. (2000), and Tyler and Nagy (1989, 1990).

MA task 2 (written): Sentence completion. In this task, the participants were presented with 20 written sentences that each had a clue word, and they were asked to write the correct form of the word to complete each sentence. Half of the target words required application of inflectional morphology, whereas the other half required application of derivational morphology. An example of this task was “/sʰadi:q/ (friend): I have three _____.” The correct answer would be /ʔsʰdiqa:ʔ/ (friends). The participant’s score was the number of items correct. This task is based on the work of Carlisle (2000).

MA task 3 (written): Morphological decomposition. The participants were shown 20 incomplete sentences, each with a complex polymorphemic clue word, and asked to complete

each sentence in writing with a smaller word that is related to the clue word. Half of the items required different inflectional morphology processes, and the other half required derivational morphology processes. In all sentences, the participants were expected to reduce the number of morphemes in the given complex word. The correct responses varied in the type of morphological operations (e.g., plural inflected verb to singular inflected verb; plural noun to singular noun; dual to singular, and so on). An example of this task was “/ʔamTarat/ (it rained): The rain /maTar/ falls in the winter season.” Another example was “/kita:ba:n/ (two books): I read a book /kita:b/.” The score was the number of items answered correctly. This task is based on the work of Carlisle (2000).

MA task 4 (written): Morphological composition. This measure had two parts. In the first (13 items), participants were presented with 13 written words plus prefixes and/or suffixes, and asked to write them as complete words (all of these were to be composed in a linear fashion). For example, children were shown “t + ʔistaqbala + hum”, for which the correct response is “tastaqbiluhum” (she received them). Another example that required more change at the phonological and orthographic levels was “/j/ + /ʕa:da/ “ (correct answer “/yaʕu:du/ (to return). The other seven items on this test targeted the broken plural (irregular inflection) in Arabic by presenting children with a picture of one object (e.g., rabbit) /ʔarnab/, then a picture of five rabbits, and asking the child to say the name of the plural form which is /ʔara:nib/. The rationale for this was the non-linear quality represented in the broken plural. Participants’ scores were the number of correct responses. This task was based on the work of Carlisle (1985, 1988).

MA task 5 (oral): Morphological relation judgment. The participants were presented orally with 20 pairs of words and asked if the two words in each pair were morphologically related (shared the same meaning). Half of the items were morphologically related pairs and half

were phonologically related foils. For example, “/mi”za:n/ and /zama:n/” (scale, time) were not related, whereas “/muTa:laʕa/ and /Ta:laʕa/” (reading, read) were related. The participant’s score was the number of items correct. This task was based on the research of Derwing (1976) and Carlisle and Nomanbhoy (1993).

MA task 6 (oral): Standard word analogy. In this task, children were asked to supply words that completed morphological analogies. They were told a pair of words that had a morphological relationship, and then asked to apply that same relationship to a third word. For example, if the tester said /kataba (he wrote): katabu:/ (they wrote), and then /laʕiba/ (he played), the child was supposed to say /laʕibu:/ (they played). To reduce the likelihood of participants responding according to phonological cues (Kirby et al., 2012), some items included irregular formation processes or a phonological shift. There were 20 items, and the participant’s score was the number of items correct. This task was based on the research of Nunes et al. (1997) and Kirby et al. (2012).

MA task 7 (oral): Local word analogy. This test followed the same format as the Word Analogy (Standard) except that the words were taken from the spoken Emirati dialect. An oral measure of morphological awareness was included to represent the spoken dialectic, particularly because the participants were children and their formal exposure to standard Arabic had been mainly through three years of schooling. The participants were required to respond orally in the local dialect to complete each analogy. For example, if the tester said /finja:n/ (cup):/fana:ji:n/ (cups) :: /rajja:l/ (man), the correct answer would be /rajji:l/ (men). Some items required more phonological shifts than others. Recall the only written form of Arabic is the Standard language, hence it is not appropriate to attribute orthographic shift to the local word analogy task. There were 20 items and a participant’s score was the number of items correct.

MA task 8 (oral): Sentence analogy. In each Sentence Analogy item, participants were presented orally with two sentences in Standard Arabic that had a morphological relationship, and then asked to apply this relationship to a third sentence. To reduce the likelihood of participants responding according to phonological cues, some items included irregular formation processes or a phonological shift. For example, “/ha:ð:hi **ḍ̣ʒari:da/** (this is a **newspaper**) :/ha:ði hi **ḍ̣ʒara:ʔid/** these are **newspapers::** /ha:ða **qalam/** (this is a **pencil**), the correct answer would be “/ha:ð:hi **ʔaqla:m/** These are **pencils.**” The transformation in this example requires irregular plural formation in which there is a phonological change between the first plural /ḍ̣ʒara:ʔid/ and the second plural/ʔaqla:m/. There were 20 items and a participant’s score was the number of items correct. This task was based on the research of Nunes et al. (1997).

MA task 9 (oral): Word analysis. This 20-item task asked the participants to generate as many smaller words as possible from given polymorphemic complex words. Participants were asked cue questions such as: Is there a smaller word in the given word that means something like the given word? For example, the word /mudarrisu:n/ (teachers) contains /mudarris/(teacher), /darrasa/(to teach), /darasa/(to study), and /dars/(lesson). Each of these words is derived by means of a different word pattern calling for different vocalic/phonological form. Children were given corrective feedback on practice items, to ensure that they understood they needed to strip the word into its smallest constituting word or root in some cases. The scoring scheme for this task ranged from zero when the child was not able to provide any smaller and related word from the given polymorphemic words; one point when the child provided a smaller word from the target, but was not the smallest possible word; and two points when the child was able to provide the smallest word or root from the target word. There were 20 items, so the maximum score for

this test was 40. This task was based on the research of Rubin (1988) and Carlisle and Fleming (2003).

MA task 10 (oral): Picture choice. Participants were shown 20 sets of four pictures, and asked to choose the picture that correctly represented the target word spoken by the experimenter. In designing this task, the four pictures selected for each individual item included ones which: (a) corresponded to the target word; (b) represented a word morphologically related to the target word, but was semantically wrong; (c) was phonologically and semantically similar to the target word, but was incorrect morphologically; and (d) was phonologically and orthographically similar to the target but was incorrect semantically and morphologically. The pictured words assessed children's knowledge of a variety of inflectional and derivational morphemes. For example, when the target spoken word by the examiner was "/tuffa:Hataan/ (two apples), the child was shown pictures of: (a) /tuffa:Hataan/ (two apples); (b) /mawzata:n/ (two bananas); (c) /tuffa:Ha/ (one apple); and (d) /mufta:H/ (key). Each participant's score was the number of correct answers. This task was based on the research of Casalis and Louis-Alexandre (2000).

Reading measures. Two reading measures were constructed, one with real words and one with pseudowords. The words in each of the reading measures increased in degree in degree of difficulty and number of syllables.

Word reading. The real words were selected based on the frequency count from two sources each representing a different corpus. One source was the lexical database of Modern Standard Arab known as Aralex (Boudelaa & Marslen-Wilson, 2010). Aralex consists of 40 million word tokens primarily drawn from Arabic newspapers available online, and includes information about orthographic forms, vowelized stems, unvowelized stems, roots, and word

patterns. Aralex also provides statistical information about words and morphemes. The second source was a corpus of 147527 word tokens compiled from Arabic textbooks used in primary schools (Grades 1-6) from two Arab countries (Libya and UAE) by Belkhouche, Harmain, Al Najjar, Taha, and Tibi (2010). Words chosen for the reading test ranged in frequency from most frequent as in the preposition /fi:/ (in) with a frequency of 32189 in Aralex (and 4100 in the textbook corpus) to the lowest frequency of .13 in Aralex (and 1 in textbook corpus) as in the one-word phrase /lijabi:ʕaha:/ (to sell it).

All real words were vowelized and represented different parts of speech with nouns comprising the largest percentage followed by verbs, adjectives, and particles. Words also varied in frequency rate, and the number of syllables ranged from monosyllabic to five-syllable words. There were 80 words in the word reading measure (see Appendix C). Each word was vowelized and appeared in Times New Roman font, size 26. Words were arranged in order of decreasing frequency and increasing number of syllables. Participants were instructed to read each word out loud with its complete vowelization. The score for the reading measures was one point for each word read accurately. The termination rule was 10 consecutive errors. The rule of 10 consecutive errors was chosen based on the assumption that because of the increasing difficulty of the words, subjects will show true ceiling effect after getting 10 consecutive words incorrect. It is important to note here that there are no standardized Arabic reading tests with agreed upon termination rules. Also, this was the first time a reading test was developed based on the frequency count of Aralex.

Pseudoword reading. The pseudoword reading test was also developed based on the Arabic structure of words. Pseudowords varied in number of syllables, and in orthographic, morphological, and phonological structure. The set of pseudowords included all Arabic letters

and captured a variety of different word-patterns. The test consisted of 20 vowelized pseudowords, arranged in order of expected difficulty (see Appendix C). Children were also asked to read all pseudowords with their vowelizations. One point was given to every pseudoword word read accurately. The termination rule was four consecutive errors.

Data analysis (Phase I). Factor analysis and hierarchical regression analysis were the primary data analytic strategies for Phase I. To answer the first question about the dimensionality of the 10 MA measures, principal axis factor analysis with direct oblimin rotation was employed. To investigate the degree to which MA predicted word reading and pseudoword reading, two hierarchical regression analyses were conducted, one for each reading outcome. In each model gender and age were entered first.

Phase II: Investigating Linguistic and Cognitive Skills in Component Skills of Reading

The purposes of the second phase of data collection and analyses were to: (a) explore the joint and unique effects of each of the widely studied predictor variables (PA, OP, MA, RAN, memory, vocabulary, and nonverbal ability) in reading in Arabic-speaking, Grade 3 children; and (b) examine the reading construct in Arabic.

Participants. Approvals were obtained from the Queen's University Research Ethics Board (see Appendix A) and the verbal approval from the Ministry of Education in Dubai, UAE. Following the results of a power analysis (Tabachnick & Fidell, 2007), 201 (101 males, 100 females) third grade Arabic-speaking children were recruited from elementary public schools in Dubai, United Arab Emirates (UAE). Children were randomly selected from the list of elementary public schools in Dubai provided by the Ministry of Education in UAE. The children came from a broad range of public female and male schools in Dubai, representing a range of socioeconomic backgrounds. The criteria for inclusion in the study were informed parental

consent (see Appendix A for Parent Consent form and Parent Information letter) and native Arabic speaking Emirati children with both parents as native speakers of Arabic. All participants were native Arabic speakers without any frank signs of hearing, visual, or language impairment. The primary mode of instruction in all subjects in the public schools in Dubai is Arabic. The children were tested in the first term of school year starting in September 2014 (mean age = 97 months, SD = 5.4).

Procedure. Participants completed a series of tasks (described below) that were administered by the researcher, a native Arabic speaker, and an Emirati Arabic research assistant who was rigorously trained and supervised by the researcher and who worked as an Arabic curriculum specialist. The research assistant administered all group tests that were given to groups of 4-5 children. The researcher gave all tests that were individually administered to ensure accuracy of response time for scores, consistency in the examiner's pronunciation of the oral stimuli, and accuracy in transcribing reading errors using the International Phonetic Alphabet (IPA) symbols. Testing took place in a quiet room in their school.

Task administration for each child was conducted in two 45-60 sessions. In each session, children were given both oral and written tests in an attempt to diversify the type of tasks. All tasks were given in a fixed order. Although task order was kept constant, children were given the choice to stop and take a break if they wanted to at both sessions. Nevertheless, children finished all tests within a 2- to 3-day period. For the written tests, children were instructed to read carefully the sentences presented in print and were given a pencil to use for writing or circling the correct choice. All tests were preceded by practice items (3-4) to ensure that children understood task demands. They were given corrective feedback when needed during the practice trials. All instructions were given in the Emirati dialect. Testing started in the beginning of the

school year in September, 2014 and was completed by January, 2015. All tasks that served as control and as outcome measures are shown in Table 4.

Table 4

Test Measures that Served as Control and Outcome Variables

Control measures		Outcome measures
<u>Cognitive tasks</u>	<u>Linguistic tasks</u>	<u>Reading tasks</u>
Matrix Analogies Test (MAT)	Phonological awareness (PA)	Single word reading I
Peabody Picture Vocabulary Test (PPVT)	Orthographic processing (OP)	(accuracy)
Forward digit span	Morphological awareness (MA)	Single word reading II
Backward digit span		(fluency)
Rapid Automatized Naming (RAN) for digits and objects		Pseudoword reading
		(accuracy)
		Text reading fluency
		(fluency & accuracy)
		Reading comprehension
		(Maze)

The test administration order for the first session was as follows: (1) nonverbal ability; (2) single word reading I (accuracy only); (3) forward memory for digit span; (4) root awareness; (5) written sentence completion; (6) word chains; (7) standard word analogy; (8) text reading fluency; (9) RAN-object naming; and (10) phonological awareness (syllable deletion). The order for Session 2 was: (1) vocabulary; (2) pseudoword reading; (3) backward memory digit span; (4) morphological production through decomposition; (5) orthographic choice; (6) local word analogy; (7) single word reading II (fluency); (8) phonological awareness (phoneme deletion and blending); (9) RAN-digit naming; and (10) reading comprehension. Considering the number of tests, the number of subjects needed to conduct analyses was determined following a power

analysis (Tabachnick & Fidell, 2007). Below is a description of the final experimental battery that was administered to all participants. These tests are organized under the three constructs, cognitive, linguistic and reading processes that are presented by the respective tests.

Experimental measures.

Cognitive predictor measures. Six cognitive control measures were administered to all participants: verbal ability (PPVT), nonverbal ability (Matrix Analogies Test), Rapid Automatized Naming (objects and digits), and memory for digits (forward and backward). A detailed description of each of the measures follows:

Verbal and nonverbal ability. Two intelligence measures were administered. The Matrix Analogies Test (MAT) – Expanded Form (Naglieri, 1985) was used to measure general nonverbal intellectual ability. Each of the 34 items on the test required children to identify which of six designs best completes an incomplete pattern. All items were administered to every child. Each correct answer is awarded one point so that scores on the complete test range from 0 to 34. To measure verbal ability, the researcher translated the Peabody Picture Vocabulary Test - Third Edition (Dunn & Dunn, 1997) into Modern Standard Arabic. The translated version was shared with four Arabic language curriculum specialists at the Ministry of Education in Dubai, and one professor of Arabic language at a National University in UAE. This resulted in corrections to 6 items. This test was employed to measure verbal ability, and required the child to point to one of four pictures to best represent a word spoken by the examiner. Ninety-six items were grouped in sets of 12 starting from Set 5 and ending with Set 12. All children started with Set 5 (age 6-7 years). Testing was discontinued when the child responded incorrectly on seven items in a set.

Memory. Short-term memory and working memory (WM) (Baddeley, 2000; Siegel, 1994; Siegel & Ryan, 1989) were assessed. For short-term memory, the forward digit span from the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) was used. As for the working memory, backward digit span was developed for the purpose of the study similar to the forward digit span with regard to number of digits progressing from easy to more difficult. Each test included 21 items increasing in difficulty. Each test was preceded by three trial items, and was discontinued if the participant missed three items with the same number of digits consecutively. The score was the number of correct test items.

Rapid automatized naming (RAN). Two measures of naming speed were administered (both taken from the CTOPP, Wagner et al., 1999). Each child was asked to rapidly name the items presented (digits or objects). The standardized testing and scoring procedure was followed. Correlations between the efficiency scores of the two RAN measures (object and digit naming) was moderately significant ($r = .45, p < .01$).

Linguistic predictor measures. The linguistic control measures included two tests of orthographic processing (orthographic choice and word chain), three tests of phonological awareness (phoneme deletion, syllable deletion, and blending), and five tests of morphological awareness (root awareness, sentence completion, local word analogy, standard word analogy, and morphological decomposition).

Phonological awareness. Three phonological awareness tests were given orally: phoneme deletion, syllable deletion, and blending (see Appendix C). The phoneme deletion comprised of three subtests: initial phoneme deletion, middle phoneme deletion, and final phoneme deletion; hence, a total of 32 items. On this test, each child was instructed to delete a

phoneme either in the initial, middle or final position. Each phoneme deletion subtest was preceded by three practice items. The examiner said the word to the child, and asked the child to repeat the word, and then say it without a particular phoneme either in the initial, middle, or final position (e.g., “Say /azraq/ “blue” without the /z/ /araq/ “blue”). Feedback was given on all trial items. The test was discontinued if the participant missed four consecutive items. If the participant requested, the examiner was allowed to repeat the word once. The score was the number of correct test items.

The syllable deletion task included a total of 48 items, preceded by three practice items. The first six items were easier ones, to ensure that all children fully understood the task. Feedback was provided for the three practice items, and the first four test items only. The test was discontinued if the participant missed five consecutive items. If the participant requested, the examiner was allowed to repeat the word once. The score was the number of correct test items. In the Word Blending test, the examiner pronounced a series of separate sounds and the participant was to combine them into a whole word (e.g., “sh-ē” into “she”) for a total of 25 items. Feedback was provided for the three practice items, and the first four test items only. The test was discontinued if the participant missed four consecutive items. If the participant requested, the examiner was allowed to repeat the word segments once. The score was the number of correct test items.

Orthographic processing. Orthographic choice and word chain tests were developed and administered to each child. For the orthographic choice test, a 60-item paper-based task measured children’s ability to identify correctly spelled words (see Appendix C). Each item consisted of a real word and its misspelled pseudoword. Children were asked to circle the correctly spelled words. The misspelled “words” were designed to have either a) the same

pronunciation as the correctly spelled word (Conrad & McNutt, 2008), b) the pronunciation of a sound in the dialect instead of its correct standard phoneme, or c) incorrect grapheme shape due to its position in the word. Participants were given feedback on three practice items. The score was the total number of correct answers. The word chain test consisted of forty-seven words presented on 11 lines without any spaces between words (see Appendix C). Children were asked to indicate the missing spaces between the words by placing a slash between the words (e.g., friendatshopdogbig; correct answer: friend/at/shop/dog/big) with a time constraint of 2 min. This test was preceded by four trial items and children were provided with feedback on each of the trial items only. The total score of this task was the number of correct slashes minus the incorrect and omitted slashes up to the last response.

Morphological awareness. Five measures of morphological awareness (MA) were administered with 20 items in each measure. The five MA measures included four tests from the 10 measures previously validated in the pilot study: local word analogy, standard word analogy, sentence completion, and morphological production through decomposition. These four MA tests were selected to measure MA, because they have high reliability estimates, and vary in their dimensions: composition-decomposition; oral-written; spoken dialect-standard; word-sentence level; and inflectional-derivational. The newly added fifth MA test was the root awareness test. It was deemed necessary to include the root awareness test because the root is a salient feature of Arabic lexical structure. The root awareness test included 20 items. Participants were required to select the correct answer(s) from a choice of six vowelized alternative words that are morphologically related to the stimulus root. Although this test was administered in groups of four to five children, each child was instructed individually prior to undertaking the test. The examiner told the participants there are six words in brackets that belong to the same family as

this word (referring to the root) explaining that these words belong to the same family because they share meaning with the root, whereas other words do not belong to the same family because they have a different meaning. For example, the stimulus word (root) /kataba/ “to write” shares meaning with /kitaab/ “book”, /kutub/ “books”, /maktab/ “desk”, and /kaatib/ “writer”, but does not, for example, share any meaning with /kabata/ “to suppress”, or /kaḏba/ “to lie”.

Children were instructed that when they see words sharing the meaning of the root word, these words belong to the same family as the root word. Then they were told to underline or circle all words that shared meaning with the root stimulus. Further, the children were instructed that when words do not share meaning with the root, these words should be left alone and not circled or underlined. This test included three trial items that were administered individually to each child prior to beginning the group-administered test. The root awareness test was administered in groups of four-five children. The test was presented in writing on A4 paper, and all stimuli (roots and the six choice options) were vowelized to avoid confusion that might be caused by homography. Participants received one point for each correct answer selected, and one point when not selecting the wrong answer. Participants lost one point when they chose an incorrect answer or left out a correct answer. The total score for the root awareness test was 120 points. This test included 20 items with six choice options per item. The items varied in the number of correct choices. For example, some items had two correct choices whereas other items had five correct choices. None of the items had all six correct choices.

The five current MA tests covered the wide range of tasks that varied across the taxonomy explained above (Deacon et al. 2008). Hence the MA tests varied in the degree to which they (a) assess implicit or explicit knowledge; (b) require morphological production, composition, or judgment; (c) require oral or written answers; (d) involve stimuli at the word or

sentence levels; (e) include inflections, derivations, or compounds; (f) manipulate phonological and orthographic shifts; and (g) whether they rely on short-term memory or not. The local and standard word analogy tests were administered orally with a termination rule of 4 consecutive errors, and the split-half reliability scores are .92 and .86 respectively. The other MA tests (root awareness, written sentence completion, and morphological decomposition) were administered in writing, and without any termination rule. Table 5 shows the instructions, number of items, examples, and the Cronbach's alpha for each of the written MA tests. Appendix C shows the actual MA measures in Arabic.

Table 5

Description of Morphological Awareness Measures

Name of test	Reliability Estimates	Example
Root Awareness	.90	<i>Children were asked to select from a choice of six alternatives the correct words that are morphologically related to the same stimulus word provided (root) (e.g., catch: musk, thick, caught, we catch, thickness, fish).</i>
Sentence Completion	.80	<i>Children are asked to complete each sentence with the correct form from the given word (root).</i> <i>(e.g., “to clean.” The teacher said: we have to keep the _____ of the school. The target response is “cleanliness” which is a derived noun from the given root.</i>
Local Word Analogy	.92	<i>The child needs to produce orally a local word to complete an analogy provided in Local Oral language.</i>
Standard Word Analogy	.86	<i>The child needs to produce orally a word in the standard form to complete an analogy provided in the Standard form of the language. (e.g., she student: plural female students (regular):: he student: plural male students (irregular).</i>
Morphological Decomposition	.83	<i>Children were provided in writing with a derived word and a sentence that has a blank. The child was expected to complete the sentence with the correct form of the provided word. This is done by decomposing the stimulus word into a smaller word. (e.g., the child is given the word “farmer” and asked to complete the sentence with the correct word by decomposing it: “The plowed fields are on the _____.” (farm).</i>

Reading outcome measures. Five outcome measures of reading were administered for all participants: (a) word reading (accuracy); (b) pseudoword reading (accuracy); (c) word-reading fluency; (d) text-reading fluency; and (e) maze comprehension. A detailed description of each of the measures follows:

Word reading. Word reading accuracy was measured by a total of 87 vowelized words that included the 80 words that were developed and validated in the previous pilot study in addition to newly added seven multisyllabic words that increased in difficulty. All 87 words that were administered in this study were provided in order of increasing difficulty based on findings from the previous pilot study (Phase I). Each participant was asked to read the words presented visually on laminated A4 papers. The test was discontinued after seven consecutive errors. The original 80 words used in the pilot study were selected based on the frequency count from two different sources each representing a different corpus. One source was the lexical database of Modern Standard Arabic known as “Aralex” (Boudelaa & Marslen-Wilson, 2010). Aralex is based on 40 million word tokens. To clarify the notion of word token, in the sentence “White is White” there are 3 word tokens, but only two word types. These words were primarily drawn from Arabic newspapers available online, and include information about orthographic forms, vowelized stems, unvowelized stems, roots, and word patterns. Aralex also provides unique statistical information about words and morphemes, because it is the first database to provide statistics about morphemes (i.e., roots and word patterns). The other source was a corpus of 147,527 word tokens compiled from Arabic textbooks used in primary schools (Grades 1-6) from two different Arab Countries-Libya and UAE (Belkhouche et al., 2010). All words were vowelized, and represented different parts of speech with nouns comprising the largest percentage followed by verbs, adjectives, and particles. Words also varied in frequency rate

ranging from most frequent to least in ascending order (40760-100); number of syllables (monosyllabic- five-syllable words); and morphological structures (roots and word patterns). The total number of the words presented on the word reading measure was 87 words (see Appendix C). The first 80 words came from the previously conducted pilot study mentioned in Phase I, and seven more multisyllabic and polymorphemic words were added. Words that shared the highest and lowest frequency rates on Aralex and the textbook corpus were included. Each word was vowelized and appeared in Times New Roman font, size 26. The score was the total number of words read accurately.

Pseudoword reading. A total of 30 pseudowords were given (see Appendix C). Twenty words came from the original pilot study, and 10 extra multisyllabic pseudowords were added to increase the degree of difficulty. The pseudowords varied in number of letters, number of syllables, covering all Arabic phonemes and various orthographic combinations some of which containing real word patterns. All pseudowords appeared on a laminated A4 paper. Children were asked to read all pseudowords with their complete vowelization. The score is the total number of accurate reading.

Word-reading fluency. The participant was presented with 55 vowelized words of increasing length (see Appendix C). Each participant was asked to read out loud quickly and accurately as many words as possible in 60 seconds. The score for this test is the number of correct words read per minute (hereafter, CWPM). Although the score for this test reflects the efficiency with which the words were read, the term fluency will be used throughout this manuscript, given its wide use in the literature (e.g., Adlof et al., 2006; Fuchs et al., 2001; Jenkins et al., 2003; Kim, 2015; Kim, et al., 2014; Kim, Wagner, & Foster, 2011; Nathan & Stanovich, 1991; Silverman et al., 2013). Reliability was estimated by correlating the word-

reading fluency with the text-reading fluency ($r = .83, p < .01$).

Text-reading fluency. A text reading speed measure was created using a vowelized unfamiliar Grade 3 passage. Participants were asked to read the passage out loud as accurately and as quickly as possible. The passage included 111 words ranging in number of syllables from one- to six-syllable words (see Appendix C). Because Arabic is an agglutinative language and highly morphemic, some of the words in the text included multimorphemic words with two to three inflectional morphemes. The score on the test is the number of words read correctly (i.e., not including the errors) per minute. Similar to the word-reading fluency in this study, the term fluency will be used throughout the manuscript. Reliability was estimated by correlating this measure with the word-reading fluency as stated above ($r = .83, p < .01$).

Maze comprehension. Four previously unseen passages were created for the purpose of this study to assess silent reading comprehension (see Appendix C). Participants were instructed to read silently a series of four passages increasing in length, syntactic structures, and degree of inferencing required. In each passage, the first sentence was left intact to provide a meaningful start. After that, each sentence contained brackets with three choices (e.g., “It was a windy day. Ahmed decided to fly his kite (expensive, high, green).” The choices included one correct answer and two distractors. The participant had to choose which of the three words best fits into the sentence (e.g., There was a car accident; a car hit one of the _____ boys. The choices will be: /hi:ta:n/ “whales”, /dʒi:ra:n/ “neighbors”, /ni:ran/ “fires.” The correct answer will be the word “neighbors”). The two distractors were either semantically incorrect or morphologically and semantically incorrect, but shared with the correct answer the phonological or orthographic structure. Some test items assessed explicit understanding, whereas other items assessed inferential comprehension. The total number of correct answers across the four passages is 35

items. The score for the child was the number of correct responses on all four passages.

Data analysis (Phase II). Factor analysis and hierarchical regression analysis were the primary data analytic strategies. The second research question addressed the contribution of each of the standard predictors to each of the five reading component outcomes. To answer this question, the following steps were followed. First, three reading measures were developed in addition to the two reading measures previously tested in Phase I. Second, a new set of Arabic linguistic measures were created for each of the following constructs: PA, OP, and a new MA measure (root awareness), in addition to translating the PPVT test. Third, participants' scores were inspected for missing data. Seven participants were removed because they were not able to perform any reading or written tests. Hence, the final set of data was comprised of 194 participants. Next, reliability measures were calculated for each measure. Fifth, composite scores were created for some of the predicting constructs (PA, OP, and RAN) by creating z-scores. Sixth, principal factor analysis with direct oblimin rotation was used to determine the number of underlying constructs representing the five MA measures, four of which were selected from the 10 MA measures previously validated in Phase I, and the newly added root awareness MA measure. Lastly, another principal factor analysis with direct oblimin rotation was used to determine the number of underlying constructs representing the five Arabic reading measures; and (8) different sets of hierarchical regression analyses were conducted to investigate the effect of each predictor in the presence of other predictors to each of the five reading outcomes. The third research question aimed at examining the construct of reading in the Arabic language. To achieve this aim, principal axis factor analysis was used to determine if the five reading measures are distinct from each other.

Chapter 4

Results

In order to answer the research questions that were the focus of this research, the data collection and analyses occurred over two phases. Results of both, Phase I and Phase II are reported in this chapter. The overall structure of the results includes the following sections: purposes, descriptive statistics and reliability scores, correlational data, factor analysis, hierarchical regression analyses, and summary of findings (for Phase II). Findings of Phase I results will be reported first, followed by the Phase II results.

Phase I (Pilot Study)

The main purposes of Phase I were to examine the dimensions underlying morphological awareness (MA) in Arabic (construct validity), and to determine how well MA predicted reading (predictive validity). Descriptive statistics (means and standard deviations) and split-half reliability for all measures were calculated. Each task was also analyzed for skewness and kurtosis values, and transformations were performed when needed because there is an assumption of normal distribution of the data for most types of statistical analyses. Factor analysis was used to explore the dimensionality of MA. Lastly, hierarchical regression analysis was used to explore the role of MA in word reading and pseudoword reading after controlling for age and gender.

Descriptive statistics and split-half reliability estimates for all variables are displayed in Table 6. The word reading, pseudoword reading, and nine of the 10 MA test distributions showed negative skewness. The exception to the skewness among the 10 MA tests was the standard word analogy. All skewness problems were solved by logarithmic and square root transformations, except for the sentence completion test which was transformed by winsorizing (following the guidelines of Tabachnick & Fidell, 2007).

Correlations between measures are reported in Table 7. Correlations among MA tests ranged from .12 to .63 and were mostly significant with the exception of the Morphological Relation Judgment (an oral test) that was not strongly correlated with three written tests (morphological composition, morphological decomposition, and sentence completion). The two oral MA tests that varied in use of language structures (Standard and Local Word Analogy) were significantly correlated ($r = .63, p < .01$). The two reading (word reading and pseudoword reading) measures were correlated significantly ($r = .78, p < .01$). All of the MA tests correlated significantly (range .22 to .60) with both reading tests (word reading and pseudoword reading).

The dimensionality of the 10 MA tasks was examined using the principal axis factor analysis with direct oblimin rotation. The Kaiser-Meyer-Olkin measure (Kaiser, 1970) of sampling adequacy was .84, above the recommended value of .6. Bartlett's test of sphericity was significant ($\chi^2(45) = 321.69, p < .05$). Finally, the communalities were all above .3, further confirming that each MA task shared some common variance with other MA tasks. These results indicate that factor analysis was appropriate. The first eigenvalue was substantial (4.11), much larger than the second (1.09) and subsequent eigenvalues. Every test except two loaded well on this factor; the exceptions were the Morphological Relation Judgment and Word Analysis (Table 8). This one-factor solution accounted for 40.1% of the variance. Regression factor scores were generated from this one-factor solution and were labelled Morphological Awareness (MA). The final line in Table 7 shows the correlations between the MA factor score and all of the other variables (cognitive and linguistic predictors and reading outcomes). The MA factor score was correlated significantly with both real word reading ($r = .68, p < .01$) and pseudoword reading ($r = .61, p < .01$).

Table 6

Summary of descriptive statistics on all tasks (N = 102)

Measure	Min	Max	Mean	SD	Split-half Reliability
Picture Choice	13	20	18.97	1.13	0.62
Sentence Analogy	0	18	12.63	4.21	0.86
Standard Word Analogy	0	18	10.57	4.48	0.88
Local Word Analogy	0	19	13.37	4.34	0.86
Morphological Relation Judgment	5	20	18.19	1.93	0.67
*Word Analysis	0	37	30.53	5.92	0.82
Sentence Selection	5	20	17.01	2.87	0.78
Morphological Composition	0	20	14.08	5.22	0.92
Sentence Completion	0	20	15.32	4.06	0.91
Morphological Decomposition	0	20	16.26	3.62	0.87
*Word Reading	2	78	59.54	19.497	0.98
Pseudoword Reading	0	20	15.76	4.412	0.85

**Note. The maximum possible score for Word Analysis = 40, for Word Reading = 80, and for all other measures =*

Table 7

*Correlations between Morphological Awareness (MA) Measures**Note.* †Transformed variables, * $p < .05$; ** $p < .01$; *** $p < .001$

	1	2	3	4	5	6	7	8	9	10	11	12
1. Picture Choice†	-											
2. Sentence Analogy†	.41**	-										
3. Standard Word Analogy	.29*	.46**	-									
4. Local Word Analogy†	.23*	.45**	.63**	-								
5. M. Relation Judgment†	.24*	.21*	.30**	.27**	-							
6. Word Analysis†	.27**	.24*	.22*	.13	.24*	-						
7. Sentence Selection†	.29**	.32*	.44**	.36**	.28**	.21	-					
8. Morphological Composition†	.26**	.31*	.43**	.38**	.12	.29**	.42**	-				
9. Sentence Completion†	.35**	.42*	.47**	.42**	.17	.19	.39**	.55**	-			
10. Morphological Decomposition†	.24*	.32*	.41**	.43**	.18	.27**	.34**	.43**	.53**	-		
11. Word Reading†	.35**	.29**	.57**	.45**	.35**	.28**	.50**	.47**	.54**	.44**	-	
12. Pseudoword Reading†	.33**	.27**	.57**	.48**	.22*	.26**	.37**	.39**	.45**	.37**	.78**	-
13. MA Factor Solution	.51**	.66**	.79**	.72**	.39**	.40**	.63**	.68**	.76**	.67**	.68**	.61**

Table 8

Summary of MA Principal Axis Factor analysis (N = 102)

Test	Factor loading
Picture Choice†	.473
Sentence Analogy†	.610
Standard Word Analogy	.733
Local Word Analogy†	.664
M. Relation Judgment†	.361
Word Analysis†	.367
Sentence Selection†	.586
Morphological Composition†	.631
Sentence Completion†	.701
Morphological Decomposition†	.621

Note. †*Transformed scores*

Finally, to examine MA's relationship with reading, hierarchical regression analyses were conducted to investigate the extent to which MA predicted reading after controlling for age and gender. Previous research in English and other languages has found substantial relationships between reading and MA (Carlisle, 1995; Kirby et al., 2012; Deacon et al., 2013; Mahony, Singson, & Mann, 2000; Nagy et al., 2006). This is the first time an Arabic reading test is designed based on the frequency count (Aralex). Therefore, it was necessary once the MA construct validity was established, to investigate its ability to predict reading using the newly designed reading measures. Two regression analyses were conducted, one for real words and one for pseudowords (see Table 9). In each model, gender and age were entered in the first step and the MA factor score in the second step. Gender and age accounted for 5% of the variance in the outcomes, mostly due to gender. Morphological awareness added a significant 41 to 43% of the

variance. The beta coefficients for real word ($\beta = .67$) and pseudoword reading ($\beta = .66$) were substantial and similar; hence, supporting the predictive validity of MA in reading Arabic.

Table 9

Summary of Hierarchical Regression Analyses Predicting Real Word and Pseudoword Reading

Step, Predictor	Outcome Measure			
	Word Reading		Pseudoword reading	
	ΔR^2	β	ΔR^2	β
Step 1:	.05		.06	
Gender (M = 1, F = 2)		.22**		.27**
Age in months		-.01		-.05
Step 2:	.43***		.41***	
Gender (M = 1, F = 2)		.16**		.17**
Age in months		.10		.06
MA Factor Score		.67***		.66***
Total R ²	.48***		.47***	

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Phase II

Due to the absence of authentic Arabic MA measures, validating the Arabic MA construct was a necessary first step. Furthermore, because no previous research on Arabic reading has used a wide range of predictors and different reading outcomes, it was necessary to conduct the second Phase of this study. Therefore, the main purposes of Phase II were to (a) explore the joint and unique effects of each of the standard predictors on each of the reading outcomes, and (b) to examine the reading construct in Arabic. Phase II results include descriptive statistics including skewness information, and information related to transformations of skewed scores, reliability estimates, and correlations. Results of exploratory factor analyses on the five MA measures and

on the five reading outcomes were also reported. Different sets of hierarchical regression analyses were conducted to explore the effects of each of the standard predictors (PA, OP, MA, RAN, memory, and Cognitive abilities) on each of the reading outcomes and based on the results of factor analyses, a hierarchical regression analysis with one Reading factor score as the outcome was also conducted.

Descriptive statistics of raw scores for all predictive (cognitive abilities: MAT & PPVT, memory: forward and backward digit span, PA, OP, RAN, and MA) and outcome measures (word reading accuracy, pseudoword reading accuracy, word-reading fluency, text-reading fluency, and reading comprehension) are shown in Table 10. Noteworthy is that the mean average score for the word-reading fluency test is almost 17 (mean = 16.91) correct words per minute, whereas the mean average score on the text-reading fluency test was almost 35 (mean = 34.87) words per minute. These findings are in line with Stanovich, Cunningham, and Feeman (1984) who found that first grade children read the same words more rapidly when connected (coherent text) than out of context (i.e., isolated words).

Skewness and kurtosis values for the six measures fell outside of the acceptable range (i.e., statistic/SE < - 3.09 or > 3.09). These measures were subjected to logarithmic and square root transformations according to Tabachnick and Fidell's (2007) guidelines. Specifically, square root transformations were used to bring skewness and kurtosis values within the acceptable range for the backward memory, text reading fluency, morphological awareness, sentence completion, orthographic choice, and word chain tasks. Morphological awareness through decomposition was the only MA task transformed by log₁₀ transformation. All further analyses were performed with the transformed variables. Tabachnick and Fidell recommended a particular sequence of transformations, beginning with a square root transformation, followed by a logarithmic

transformation. I used this sequence and tested the significance of the skewness after each transformation. Transformed scores are provided in Table 11.

Reliability estimates were calculated for all measures. For the timed measures or measures with a termination rule, split-half reliability was assessed by comparing the odd- and even-numbered items. Cronbach alpha was calculated for the measures where the participants answered all items (MAT, OP Word Choice, all written MA tests, and Maze comprehension). All the tasks had high reliability estimates with the exception of backward digit span (.67). The five MA measures have highly reliable estimates ranging from .80 to .92. The five reading outcome measures also have high reliable scores (range .83 to .98). All three PA subtests, blending, phoneme deletion, and syllable deletion have high reliability scores of .88, .94, and .95, respectively. With regard to the cognitive ability measures, the translated PPVT vocabulary measure had a reliability score of .96, and the nonverbal cognitive ability test (MAT) had a reliability score of .80. Correlations were conducted to address the test-retest reliability of the naming efficiency measures. The correlation for the two naming efficiency scores (object and digit naming efficiency) was .45. ($p < .01$). As for the two reading fluency measures, word reading fluency and text reading fluency, reliability was also estimated by correlating the measures ($r = .83, p < .01$).

Table 10

Raw Scores Descriptive Statistics of all Measures (N = 194)

Measure	Min	Max	Mean	Std. Deviation	Reliability	
					<u>Split-half</u>	<u>Alpha</u>
Nonverbal-IQ (MAT)	3	28	14.35	5.52		.80
PPVT	4	86	42.81	18.79	.96	
Forward Memory	5	15	9.07	1.98	.72	
Backward memory	0	7	1.67	1.46	.67	
RAN-Object Naming Efficiency	.39	1.56	.89	.19	.45**	
RAN-Digit Naming Efficiency	.53	2.57	1.63	.349	.45**	
PA- Syllable Deletion	0	39	21.38	8.97	.95	
PA- Phoneme Deletion	0	32	20.09	7.75	.94	
PA- Blending	2	24	14.65	5.18	.88	
OP- Orthographic Choice	13	55	39.75	7.70		.75
OP- Word Chain	-52	42	2.18	16.44	.87	
MA- Sentence Completion	0	19	12.53	3.85		.80
MA- Decomposition	0	20	13.71	4.08		.83
MA- Local Word Analogy	0	18	7.08	5.02	.92	
MA- Standard Word Analogy	0	19	8.11	3.84	.86	
MA- Root Awareness	53	111	80.60	14.82		.90
Word Reading	3	84	47.81	23.64	.98	
Pseudoword Reading	1	30	13.77	9.45	.97	
Word reading fluency	0	46	16.91	10.50	.83**	
Text reading fluency	0	110	34.87	24.60	.83**	
Maze Reading Comprehension	6	35	21.26	7.11		.88

*Note. ** ($p < .01$) Reliability was calculated by correlating measures*

Table 11

Transformed Scores (N= 194)

	Mean	SD	Skewness	SE	Kurtosis	SE
Backward Memory	1.57	.44	.19	.17	-.70	.33
Text-Reading Fluency	5.50	2.15	.03	.17	-.26	.33
MA-Sentence Completion	2.64	.71	.07	.17	-.28	.33
Orthographic Choice	4.41	.86	.05	.17	-.16	.33
Word Chain	7.52	1.07	.19	.17	1.02	.33
MA-Decomposition	1.02	.14	.33	.17	.02	.33

Composite scores were created for phonological awareness (phoneme deletion, syllable deletion, and blending), orthographic processing (word chain and orthographic choice), and naming speed (RAN: object naming and digit naming) tasks. To create composite scores for each of these three processing domains, raw scores were transformed into z-scores and then averaged. All further analyses that involved these standard predictors were performed with their respective composite scores. It should be noted here that the scores for the two memory tests (forward and backward) were not combined into a separate score. This is because of the low magnitude of their correlation ($r = .18, p < .05$).

Correlations between predictors and outcome measures are shown in Table 12. As expected, each of the five reading measures were significantly correlated with each other (range $r = .54 - .84, p < .01$), with the highest correlations between word-reading fluency and text-reading fluency tests ($r = .83, p < .01$), and between word reading accuracy and word-reading fluency tests ($r = .81, p < .01$). Word reading and pseudoword reading measures were also

strongly correlated ($r = .78, p < .01$), while pseudoword reading and reading comprehension were only moderately correlated ($r = .54, p < .01$).

Each of the standard predictors (MAT, PPVT, PA, OP, RAN, and MA) correlated significantly with the five outcome reading measures (word reading, pseudoword reading, single word reading fluency, text reading fluency, and comprehension). The five MA tests correlated significantly with each other (range $r = .28 - .64, p < .01$), the highest correlation was between the two written MA tests, sentence completion and morphological decomposition ($r = .64, p < .01$). The two oral MA tests, word analogy local and standard correlated significantly with each other ($r = .60, p < .01$). Similarly, all five MA tests correlated significantly with each of the five reading measures (range $r = .30 - .65, p < .01$). The highest correlation was between MA sentence completion and reading comprehension ($r = .65, p < .01$), followed by a significant correlation between root awareness and word reading ($r = .63, p < .01$). The MA factor score correlated significantly with the five reading measures (range $r = .56 - .70, p < .01$); the highest being .70 was between MA factor and reading comprehension. The MA factor score also correlated significantly with both, PA ($r = .66, p < .01$) and OP ($r = .65, p < .01$). PA correlated significantly with all five reading measures, the highest with word reading ($r = .75, p < .01$). The correlations between OP and all five reading measures was also significant (range $r = .59 - .68, p < .01$), and the highest correlation was also with word reading ($r = .68, p < .01$), while the lowest was with pseudoword reading. PA and OP had comparable correlations with the five reading measures. However, it is interesting that PA had slightly high correlations than OP with four reading measures, the exception is word-reading fluency where its correlation with OP was slightly higher ($r = .66, p < .01$) than with PA ($r = .63, p < .01$). RAN correlated significantly with all five reading measures (range $r = .29 - .51, p < .01$), the highest being with text-reading

fluency ($r = .51, p < .01$) followed by word reading fluency ($r = .45, p < .01$). The PPVT correlated significantly with the nonverbal IQ ($r = .40, p < .01$), MA ($r = .43, p < .01$), and all reading measures, the highest being with comprehension ($r = .52, p < .01$). Results also showed that all standard predictors (MAT, PPVT, PA, OP, RAN, and MA) correlated significantly with reading comprehension (range $r = .32 - .70, p < .01$), the highest being with MA followed by PA, OP, PPVT, and MAT in this order.

Dimensionality of Morphological Awareness (Phase II). Similar to the dimensionality of the 10 MA measures investigated in Phase I, the dimensionality of the five reading measures in Phase II of the current study was explored. First, four out of the 10 MA measures from Phase I were selected. There are two reasons for selecting these four MA measures in particular: (a) the four MA measures have high reliability estimates; and (b) vary in their dimensions (Deacon et al., 2008): composition-decomposition; oral-written; spoken dialect-standard; word-sentence level; and inflectional-derivational. In addition, another MA measure (root awareness) was added to these four previously validated MA measures. Root awareness was deemed necessary to add because of the saliency of the root in Arabic morphology. Hence, the total number of MA measures in Phase II is five measures. The purpose of examining the dimensionality of MA in Phase II is to determine if these five MA measures represent a single construct. The dimensionality of the five MA measures was examined using principal axis factor analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was .74, above the recommended value of .6, and Bartlett's test of sphericity was significant ($\chi^2(10) = 318.50, p < .05$). These results indicate that factor analysis was appropriate. Two techniques were used to determine the number of factors to retain, including Kaiser's eigenvalues greater than one (Kaiser, 1970) and Cattell's scree test (Cattell, 1966).

Table 12

Correlations between transformed variables (predictors and reading outcomes)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Nonverbal IQ (MAT)	-													
2. PPVT	.40**	-												
3. Forward digit span	.20**	.05	-											
4. Backward digit span	.13*	.08	.18*	-										
5. RAN	.07	.05	.12	.27**	-									
6. PA	.34**	.36**	.29**	.37**	.31**	-								
7. OP	.26**	.25**	.44**	.29**	.22**	.65**	-							
8. MA	.43**	.43**	.33**	.30**	.12	.66**	.65**	-						
9. Word Reading	.20**	.35**	.28**	.31**	.37**	.75**	.68**	.64**	-					
10. Pseudoword Reading	.22**	.23**	.22**	.25**	.29**	.61**	.59**	.57**	.78**	-				
11. Word Reading Fluency	.17*	.28**	.18*	.30**	.45**	.63**	.66**	.56**	.81**	.70**	-			
12. Text Reading Fluency	.18*	.24**	.16*	.34**	.51**	.64**	.61**	.56**	.77**	.63**	.83**	-		
13. Comprehension	.47**	.52**	.27**	.30**	.32**	.64**	.61**	.70**	.71**	.54**	.66**	.66**	-	
14. Reading Factor	.28**	.37**	.25**	.34**	.45**	.74**	.72**	.69**	.93**	.83**	.92**	.89**	.81**	-

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

The first eigenvalue was substantial (2.77), larger than the second (.91) and subsequent eigenvalues. The Scree test method was also used to identify the break point where the curve flattened out. The Scree test also suggested a one-factor solution. As shown in Table 13, all five MA tests loaded well on this factor. The MA factor score explained 45.1% of the variance. Further, the MA factor score correlated significantly with all five reading measures with the highest correlation for comprehension ($r = .70, p < .01$) followed by word reading ($r = .64, p < .01$) (Table 12).

Table 13

Summary of Morphological Awareness Principal Axis Factor analysis (N = 194)

Test	Factor loading
Sentence Completion*	.83
Morphological Decomposition*	.69
Local Word Analogy	.61
Standard Word Analogy	.62
Root Awareness	.58

*Note. *Transformed scores*

Hierarchical Regression Analyses. Separate sets of hierarchical regression analyses were conducted to address the second research question. The second research question aims at investigating the role of each of the standard predictors (linguistic and cognitive) in reading. The regression analyses were conducted for each of the five reading outcome variables. In each model, the general cognitive ability measures (i.e., MAT and PPVT) were entered in the first step. In the second step, the two memory measures. After that, the sequence of predictors varied depending on the reading outcome being measured as the dependent variable. For example, for

pseudoword reading accuracy as the dependent variable, PA was entered last in the model, because PA is an established predictor of reading accuracy (Adams, 1990). When text reading fluency was the dependent variable, RAN was entered last in the model to examine its unique contribution after controlling for verbal and nonverbal intelligence and all the other variables that may have contributed to reading fluency. RAN has been shown to have a significant unique contribution to reading speed (or fluency) after controlling for other factors (Georgiou et al., 2008; Kirby et al., 2012). Hierarchical regression analyses for each of the five reading outcomes will be presented. After that, a summary of all hierarchical regression analyses will be presented in one Table (see Table 24) including all standard predictors and the five reading outcomes.

Prediction of word reading. Phonological awareness (Abu-Rabia, 1996, 1999; Adams, 1990; Share, 1995) was expected to account for unique variance in Arabic real word reading. Table 14 presents the results of the regression analysis used to determine the relative contributions of each of the standard predictors to real word reading. To control for individual differences in cognitive ability (MAT and PPVT), these variables were entered in the first step of the equation. Together the two predictors accounted for 13% of the variance in word reading. Five other predictors were then entered individually in Steps 2 through 6 in the following order: (a) forward and backward memory for digits both entered in Step 2, (b) RAN (the composite score of object and digit naming) was entered in Step 3, (c) orthographic processing (the composite of word chain and orthographic choice) was entered in Step 4, (d) phonological awareness (the composite of phoneme deletion, syllable deletion, and blending) was entered in Step 5, and (e) morphological awareness (MA factor score of five MA measures) in Step 6. MA was entered in the final step, to estimate its effect after accounting for cognitive abilities and the established predictors of naming, OP, and PA. The five predictors contributed an additional 55%,

for a total of 68% of variance accounted for in the model. Orthographic processing accounted for the most variance, contributing 24% of the variance, followed by the verbal and nonverbal abilities, both contributing 13% of the variance, followed by the memory tests contributing 12%, and followed by phonological awareness and naming each of which accounted for 9% of the variance. Although all predictors were significantly predictive when entered, the two memory tests were not significant in the final step of the model. Upon examination of beta weights, orthographic processing was the most important predictor when entered in the model. However, phonological awareness was the most important predictor with a final standardized beta weight of .39 ($p < .001$) in the models, followed by orthographic processing ($\beta = .26, p < .001$), naming ($\beta = .17, p < .001$), and morphological awareness ($\beta = .19, p < .01$).

Table 14

Hierarchical Regression Model for the Prediction of Word Reading

Step	R ²	ΔR^2	Predictor	β^a	β^b
1	.13***	.13***	Matrix Analogies Test (MAT)	.07	-.15
			PPVT	.32***	.11*
2	.25***	.12***	Forward Memory	.22**	.05
			Backward Memory	.24***	.01
3	.34***	.09***	RAN	.30***	.17***
4	.58***	.24***	Orthographic processing	.54***	.26***
5	.67***	.09***	Phonological Awareness	.45***	.39***
6	.68**	.01**	Morphological Awareness	.19**	.19**

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

To examine the strength of the predictors, the order of entry for the same standard predictors (RAN, OP, PA, and MA) was reversed (MA, PA, OP, and RAN). Table 15 presents these results. In comparison to the first model, the strengths of the predictors were opposite. Orthographic processing now accounted for 4% of the variance, whereas morphological awareness accounted for the most variance, contributing 20% of the variance, followed by phonological awareness, which accounted for 17% of the variance when entered in the model. Noteworthy is the role of MA in word reading. Its final beta weight was .19 ($p < .01$) when it was entered in the third step as well as in the final step. In both cases, MA maintained the significant weight of its contribution in word reading. Similarly, the significant role of naming in the step entered and in the final step ($\beta = .17, p < .001$).

Table 15

Hierarchical Regression Model for the Prediction of Word Reading with the Order of Predictors Entered in Reverse

Step	R ²	ΔR^2	Predictor	β^a	β^b
1	.13***	.13***	Matrix Analogies Test (MAT)	.07	-.15
			PPVT	.32***	.11*
2	.25***	.12***	Forward Memory	.22**	.05
			Backward Memory	.24***	.01
3	.45***	.20***	Morphological Awareness	.56***	.19**
4	.62***	.17***	Phonological processing	.57***	.39***
5	.66***	.04***	Orthographic Awareness	.28***	.26***
6	.68***	.02***	RAN	.17***	.17***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Prediction of pseudoword reading. Previous research has shown that PA plays a significant role in decoding (Abu Rabia, 1997, 1998; Adams, 1990; Ehri et al., 2001; Share, 1995; Wagner & Torgesen, 1987). To test this relationship in the current study, a hierarchical regression analysis was run to examine the effects of all predictors on pseudoword reading accuracy. To control for individual differences in cognitive ability (verbal and nonverbal), these variables were entered in the first step of the equation; together contributing to 7% of the variance in pseudoword reading. As shown in Table 16, the five standard predictors were then entered individually in Steps 2 through 6 with PA entered last. The five predictors contributed an additional 40%, for a total of 47% of variance accounted for in pseudoword reading. OP accounted for the most variance, contributing 19% of the variance. However, upon examination of beta weights, PA although entered last in the model, it was the most important predictor with a final beta weight of .29 ($p < .001$) compared to the comparable beta weights of OP ($\beta = .23, p < .01$) and MA ($\beta = .24, p < .01$). It seems that OP and PA have comparable strong contributions to both, word reading and pseudoword reading.

Table 16

Hierarchical Regression Model for the Prediction of Pseudoword Reading

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.07**	.07**	Matrix Analogies Test (MAT)	.15*	-.04
			PPVT	.17*	-.03
2	.14**	.07**	Forward Memory	.16*	.00
			Backward Memory	.19**	-.01
3	.19**	.05**	RAN	.23**	.13*
4	.38***	.19***	Orthographic processing	.49***	.23**
5	.43***	.05***	Morphological Awareness	.32***	.24**
6	.47***	.04***	Phonological Awareness	.29***	.29***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Prediction of word- and text-reading fluency. Two separate hierarchical regression analyses were conducted, one for word-reading fluency and another for the text-reading fluency as two separate outcome measures. It was necessary to run different regression analyses for each of these reading speed constructs: (a) to examine if the predictors are similarly or differentially related to word-reading fluency and text-reading fluency, and (b) because there is empirical evidence showing that although both speed constructs are highly related (Ehri, 2002), they are separate constructs (Kim et al., 2011, 2012, 2014; Kim & Wagner, 2015). Accordingly, although findings of this study showed that word-reading fluency was strongly correlated with text reading fluency ($r = .83, p < .01$), yet it was predicted that each fluency measure will have its unique distinguishing predictor(s). The weight of the standard predictors for each of these reading speed constructs would differ. It was hypothesized that OP (Apel & Apel, 2011) would

be the strongest predictor of word-reading fluency, whereas RAN would be more strongly related to text-reading fluency (Georgiou et al., 2008; Kirby et al., 2009; Savage & Fredrickson, 2005) because naming speed and text-reading fluency are both speeded measures and involve rapid serial response (Savage & Fredrickson, 2005). These results are presented in Tables 18 and 19. In both models, verbal and nonverbal abilities (MAT and PPVT) were entered in the first step of the equation; together the two predictors accounted for 17% of the variance in each of the two reading speed measures. The five other predictors were then entered individually in Steps 2 through 6.

To explore the strength of Orthographic awareness (OP) in the prediction of word-reading fluency, OP was entered last to determine its unique contribution to word-reading fluency. Table 17 presents the results of the regression analysis for the prediction of word-reading fluency. The model accounted for 60% of the variance in word-reading fluency; controls for verbal and nonverbal abilities, and memory accounted for 17% of the variance, while the other predictors accounted for an additional 43%. All key predictors (MA, PA, RAN, and OP) were predictive and highly significant when first entered in the model, however, OP ($\beta = .35, p < .001$) followed by RAN ($\beta = .30, p < .001$) were more significantly predictive in the final step. Worth noting is that RAN maintained the strength and magnitude of its beta weights in the step (.31) and in the final step (.31). MA was the strongest predictor, accounting for 17% of the variance, followed by PA and naming with 11% and 9%, respectively. Clearly, MA has a role in word-reading fluency. Although OP accounted for only 6% of the total variance of 60% in the model, its contribution is significant considering it was entered last, after robust predictors such as MA, PA, and RAN.

Table 17

Hierarchical Regression Model for the Prediction of Word-Reading Fluency

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.08***	.08***	Matrix Analogies Test (MAT)	.07	-.11*
			PPVT	.26**	.07
2	.17***	.09***	Forward Memory	.12	-.04
			Backward Memory	.26***	.04
3	.34***	.17***	Morphological Awareness	.53***	.19*
4	.45***	.11***	Phonological Awareness	.45***	.19**
5	.54***	.09***	RAN	.31***	.30***
6	.60***	.06***	Orthographic Processing	.35***	.35***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Another regression analysis was run to investigate the role of the predictors in text-reading speed (Table 18). This time RAN was entered last to assess if it would survive the statistical control of other predictors that have been established as effective predictors in previous studies (Bowers, 1995; Georgiou, Parrila, & Kirby, 2009; Kirby et al., 2009; Roman et al., 2009). The model accounted for 61% of the variance in text-reading fluency; controls for verbal and nonverbal abilities, and memory accounted for 17% of the variance, while the other predictors accounted for an additional 44%. All other key predictors (MA, PA, OP, and RAN) were predictive and highly significant when first entered in the model. The final beta weights of naming ($\beta = .36, p < .001$) and MA ($\beta = .30, p < .001$) were more significant than the beta weights of PA ($\beta = .24, p < .01$) and OP ($\beta = .22, p < .01$). MA was the strongest predictor, accounting for 19% of the variance, followed by PA and naming with 11% each. Again, MA

seems to play a key role in this speed measure of text-reading fluency. The beta weight of PA was substantial in magnitude when entered in the step ($\beta = .47, p < .001$), however, its contribution dropped about 50% from 47% to 24% in the final step ($\beta = .24, p < .01$) after accounting for OP and naming. It should be noted that the beta weight of PPVT, as a measure of vocabulary, was .20 ($p < .05$) when entered in the step, however, in the final step of this hierarchical multiple regression, this variable was no longer a significant predictor of text-reading fluency.

Table 18

Hierarchical Regression Model for the Prediction of Text-Reading Fluency

Step	R ²	ΔR^2	Predictor	β^a	β^b
1	.07**	.07**	Matrix Analogies Test (MAT)	.10	-.09
			PPVT	.20*	-.00
2	.17***	.10***	Forward Memory	.08	-.08
			Backward Memory	.30***	.07
3	.36***	.19***	Morphological Awareness	.54***	.26***
4	.47***	.11***	Phonological Awareness	.47***	.24**
5	.50**	.03**	Orthographic Processing	.26**	.22**
6	.61***	.11***	RAN	.36***	.36***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

A further regression model was created to investigate the strength of RAN in text-reading fluency, but this time after controlling for word-reading fluency, which is an established foundational skill for text-reading fluency (Ehri, 2002). RAN was predicted to make a unique contribution to text-reading fluency over and above word-reading fluency. To investigate if text-

reading fluency is dissociated from word-reading fluency (Kim & Wagner, 2015), the latter was controlled for in Step 6 in the model. Table 19 reports the results of the model. Word-reading fluency accounted for 23% of the variance in text-reading fluency, followed by MA which contributed 19%, again attesting to the significant contribution of MA in text-fluency even in the presence of word-reading fluency. The addition of word-reading fluency accounted for an additional 14% in the model. Hence, the variance accounted for by the model increased from 61% (Table 18) to 75% (Table 19). Examination of final beta weights suggested that word-reading fluency accounted for the most variance at 59% ($p < .001$), followed by RAN at 18% ($p < .001$). Noteworthy is that OP did not account for any unique variance in the final step. As for MA, although its beta weight of .54 ($p < .001$) dropped to .15 ($p < .05$), its contribution remained significant in predicting text-reading fluency.

Table 19

Hierarchical Regression Model for the Prediction of Text-Reading Fluency Including Word-Reading Fluency as a Control

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.07**	.07**	Matrix Analogies Test (MAT)	.10	-.02
			PPVT	.20*	-.04
2	.17***	.10***	Forward Memory	.08	-.06
			Backward Memory	.30***	.05
3	.36***	.19***	Morphological Awareness	.54***	.15*
4	.47***	.11***	Phonological Awareness	.47***	.12*
5	.50**	.03**	Orthographic Processing	.26**	.02
6	.73***	.23***	Word reading fluency	.69***	.59***
7	.75***	.02***	RAN	.18***	.18***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Prediction of reading comprehension. MA was predicted to contribute unique variance to reading comprehension skill above and beyond the effects of all other standard predictors, including the cognitive abilities measures and the reading fluency measures. Therefore, three separate hierarchical regression analyses were performed, one to examine the contributions of each of the predictors to reading comprehension, another controlling for the same standard predictors in addition to word-reading fluency, and the last one controlling for the same standard predictors while controlling for text-reading fluency. As in the previous analyses, verbal and nonverbal cognitive abilities were entered in Step 1 and memory was entered in Step 2 followed by PA, OP, RAN. The key variable of interest in these three models was MA for its established role in comprehension (Carlisle, 2000, 2003, 2005; Kirby et al. 2012), therefore, MA was always entered last in each of these three regression analyses.

Table 20 shows the results of the regression analysis used to determine the relative contributions of each of the standard predictors to reading comprehension. The model accounted for 66% of the variance in reading comprehension, verbal and nonverbal abilities accounted for 35%, which conforms to Kirby et al.'s (2012) finding of 40% of the variance in reading comprehension. Memory also accounted for an additional 8%. The remaining predictors accounted for an additional 19%. Morphological awareness accounted for 4% of the variance, a small but significant amount, indicating that it contributes uniquely to reading comprehension in spite of the fact that it was entered into the regression after all other predictors, and confirming its distinct role from cognitive abilities. The significant and unique effect of MA is comparable to the 6% reported by Kirby et al. (2012). In fact, in this study more variables were controlled for than in Kirby et al.'s study, which controlled for cognitive abilities and PA only. Therefore, the

significance of the 4% variance in reading comprehension of Arabic third graders maybe more robust considering that MA was entered after cognitive abilities, memory, PA, OP, and RAN.

Upon examination of beta weights, MA was the most important predictor of reading comprehension with a final beta weight of .32 ($p < .001$), followed by PPVT ($\beta = .24, p < .001$), and naming ($\beta = .18, p < .001$). Although PA had a high Beta weight at .41 when initially entered, it did not account for any variance in the final step. As for OP, its beta weight dropped from .30 to .18, but it remained significant in the final step. Similarly, nonverbal ability had a substantial beta weight of .31($p < .001$) when entered into the model, but dropped to .13 ($p < .05$). The two memory variables were significant in the step entered, however, after other variables were entered in the equation, memory did not account for any variance.

Table 20

Hierarchical Regression Model for the Prediction of Reading Comprehension

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.35***	.35***	Matrix Analogies Test (MAT)	.31***	.13*
			PPVT	.40***	.24***
2	.43***	.08***	Forward Memory	.17**	.04
			Backward Memory	.20***	.04
3	.55***	.12***	Phonological Awareness	.41***	.09
4	.60***	.05***	Orthographic Processing	.30***	.18**
5	.62**	.02**	RAN	.15**	.18***
6	.66***	.04***	Morphological Awareness	.32***	.32***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Another regression was run to test the prediction that MA should explain variance in reading comprehension above and beyond the effects on word-reading fluency. As in the previous analyses, verbal and nonverbal ability were entered in Step 1, memory in Step 2, PA in Step 3, OP in Step 4, RAN in Step 5, word-reading fluency in Step 6, and MA last. Results of this regression are shown in Table 21. The first five steps accounted for 62% of the variance. Word-reading fluency accounted for a significant amount of variance (5%), even after the cognitive abilities, PA, OP, and RAN measures were entered into the models. The fact that word-reading fluency accounts for unique variance in reading comprehension is consistent with findings from the literature discussed above (Fuchs et al., 2001; Jenkins et al., 2003; Kim et al., 2014; Kim et al., 2012; Roehrig et al., 2008). Morphological awareness accounted for an additional 3% of variance in reading comprehension, a small but significant amount of variance

suggesting that MA contributed to reading comprehension above and beyond its effects on a word-reading fluency. This finding underscores the significant role of MA in Arabic reading comprehension.

Table 21

Hierarchical Regression Model for the Prediction of Reading Comprehension Including Word-Reading Fluency as a Control

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.35***	.35***	Matrix Analogies Test (MAT)	.31***	.16**
			PPVT	.40***	.22***
2	.43***	.08***	Forward Memory	.17**	.05
			Backward Memory	.20***	.03
3	.55***	.12***	Phonological Awareness	.41***	.04
4	.60***	.05***	Orthographic Processing	.30***	.09
5	.62**	.02**	RAN	.15**	.10*
6	.67***	.05***	Word Reading Fluency	.33***	.28***
7	.70***	.03***	Morphological Awareness	.27***	.27***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

It is clear that the Beta coefficients for all the standard predictors when entered in the step are all highly significant. As shown in Table 21, the beta weights for the PPVT vocabulary (.40), PA (.41), and word-reading fluency (.33) measures were substantial and highly significant for the reading comprehension outcome. The remainder of the predictors (MAT, memory, OP, and RAN) were also significant when entered in the step. MA and word reading fluency were the most important predictors with final beta weights of .27 and .28 ($p < .001$), respectively. The verbal

and nonverbal mental ability measures remained significant in the final step, unlike the memory measures which lost their significance. While the beta weight for RAN was less than the other predictors, RAN relatively maintained its contribution in the final step with a beta weight of .10 ($p < .05$).

Another regression was run to test if MA would explain variance in reading comprehension above and beyond the effects on text-reading fluency (Table 22). As in the previous analyses, verbal and nonverbal cognitive abilities were entered in Step 1, memory in Step 2, PA in Step 3, OP in Step 4, RAN in Step 5, text-reading fluency in Step 6, and MA last. Results of this regression are shown in Table 22. Again, the first five steps accounted for 62% of the total variance. Similar to word-reading fluency as a control variable, text-reading fluency also accounted for a significant amount of variance (5%), after the cognitive abilities, PA, OP, and RAN measures were entered into the model. This result confirms that text-reading fluency has an independent contribution in reading comprehension over and above that of vocabulary, nonverbal cognitive ability, and the other predictors similar to evidence from the English literature (Kim et al., 2012, 2014). Morphological awareness accounted for an additional 3%, a small but significant amount of variance suggesting that MA contributed to reading comprehension above and beyond its effects on all standard predictors and text-reading fluency. This clearly shows that MA contributes to reading comprehension above and beyond its effects on text-reading fluency.

Table 22 shows that the beta weights of all predictors when entered in the step are all highly significant. The beta weights for the MAT (.31), PPVT (.40), PA (.41), OP (.30), and text-reading fluency (.36) measures were substantial and highly significant for the reading comprehension outcome. The remainder of the predictors (Memory and RAN) were both

significant when entered in the step only, but not in the final step. PPVT, MA and text-reading fluency were the most important predictors with final beta weights of .24 (for each PPVT and MA), and .30 for text-reading fluency. The nonverbal mental ability measure although dropped from .31($p < .001$) to .16 ($p < .01$), it remained significant in the final step, unlike the memory measures, PA, OP, and RAN which dropped significantly in magnitude and lost their significance. In sum, the highest contribution in this regression analysis for the reading comprehension outcome came from cognitive abilities, MA, and text-reading fluency.

Another regression was run to test if MA would explain variance in reading comprehension above and beyond the effects on word reading accuracy. As in the previous analyses, verbal and nonverbal cognitive abilities were entered in Step 1, memory in Step 2, PA in Step 3, OP in Step 4, RAN in Step 5, word reading in Step 6, and MA last. Results of this regression are shown in Table 23. Again, the first five steps accounted for 62% of the total variance. Word reading accounted for a significant amount of variance (5%), which is exactly the same amount of variance word-reading fluency as well as text-reading fluency accounted for. Clearly, this shows that word reading contributes independently to comprehension which corroborates evidence from Oakhill et al. (2003) on the dissociation between word reading and text comprehension as two different component skills of reading. Morphological awareness accounted for an additional 3%, a small but significant amount of variance suggesting that MA although entered last in the model, it contributed to reading comprehension above and beyond its effects on word reading. This finding of 3% variance in the reading comprehension of Grade 3 Arabic-speaking children is similar to the 2% of variance MA contributed to reading comprehension of Grade 3 English speaking children after accounting for cognitive abilities and PA (Kirby et al., 2012).

Table 22

Hierarchical Regression Model for the Prediction of Reading Comprehension Including Text-Reading Fluency as a Control

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.35***	.35***	Matrix Analogies Test (MAT)	.31***	.16**
			PPVT	.40***	.24***
2	.43***	.08***	Forward Memory	.17**	.06
			Backward Memory	.20***	.02
3	.55***	.12***	Phonological Awareness	.41***	.02
4	.60***	.05***	Orthographic Processing	.30***	.12
5	.62**	.02**	RAN	.15**	.07
6	.67***	.05***	Text Reading Fluency	.36***	.30***
7	.70***	.03***	Morphological Awareness	.24***	.24***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Table 23 shows that the beta weights of all predictors when entered in the step are all highly significant with PPVT, PA, and word reading having the most substantial and highly significant weights, 40-41% followed by OP and nonverbal cognitive ability (31%). Although the beta weights for the cognitive abilities (MAT and PPVT) dropped by 50% in the last step, they both remained highly significant confirming that cognitive abilities are important in reading comprehension regardless of the type of orthography. As for memory, PA, and OP all stopped being significant when entered in the final step, unlike RAN which maintained its significance. The largest beta weight in the final step was for word reading ($\beta = .34, p < .001$) followed by morphological awareness ($\beta = .26, p < .001$). Altogether, word reading, MA, and cognitive

abilities accounted for 42% of the total variance of 70% in reading comprehension. Noteworthy is that MA although entered in the final step, it still accounted for a significant variance above and beyond the effects on word reading and other established predictors such as cognitive abilities.

Table 23

Hierarchical Regression Model for the Prediction of Reading Comprehension Including Word Reading as a Control

Step	R ²	ΔR ²	Predictor	β ^a	β ^b
1	.35***	.35***	Matrix Analogies Test (MAT)	.31***	.18***
			PPVT	.40***	.20***
2	.43***	.08***	Forward Memory	.17**	.02
			Backward Memory	.20***	.04
3	.55***	.12***	Phonological Awareness	.41***	-.04
4	.60***	.05***	Orthographic Processing	.30***	.09
5	.62**	.02**	RAN	.15**	.12**
6	.67***	.05***	Word Reading	.40***	.34***
7	.70***	.03***	Morphological Awareness	.26***	.26***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Table 24 provides a summary of all hierarchical regression analyses with the standard predictors predicting the five different reading outcomes when cognitive abilities were entered first, followed by the standard predictors, and MA was entered last in all the analyses. Key findings shows that all standard predictors accounted for unique variance in each of the five reading outcomes. The strongest predictor of word reading, pseudoword reading, and word-reading fluency is OP accounting for 19-24% of the variance after controlling for cognitive

abilities, memory, and RAN. However, PA has the largest beta weight when entered in the last step for both word reading and pseudoword reading, whereas OP has the most substantial beta weight in the last step for word-reading fluency. The strongest predictor of text-reading fluency is RAN followed by OP. RAN also holds the largest beta weight in the final step followed by MA, PA, and OP in this respective order. MA accounted for a unique significant variance in all reading measures, mostly in reading comprehension. Although MA accounted for a small variance, its contribution is robust considering it was entered in the last step after controlling for all cognitive and linguistic predictors. Its largest beta weight of .32 ($p < .001$) was for reading comprehension. Memory (forward and backward digit span) accounted for unique variance in all reading measures (range 7-12%). However, both memory measures lost their power when entered in the last step after controlling for RAN, OP, PA, and MA. Results of memory tests will be discussed in the discussion section. Last, but not least, verbal and nonverbal abilities explained unique variance in all reading measures, the largest effect for reading comprehension. In sum, the contribution of each of the standard predictors in each of the five reading outcomes was differentiated from one another depending on the reading outcome.

Table 24

Summary of all Hierarchical Regression Analyses for All Predictors and all Reading Outcomes

Step	Pseudoword			Word Reading			Word-Reading Fluency			Text-Reading Fluency			Reading Comprehension		
	β^a	β^b	ΔR^2	β^a	β^b	ΔR^2	β^a	β^b	ΔR^2	β^a	β^b	ΔR^2	β^a	β^b	ΔR^2
1-MAT	.15*	-.04	.08**	.07	-.15**	.13***	.07	-.11*	.08***	.10	-.09	.06**	.31***	.13**	.35***
PPVT	.17*	-.03		.32***	.11*		.26**	0.07		.20*	.00		.40***	.24***	
2-Forward Digit	.15*	.00	.07**	.22**	.05	.12***	.12	-0.04	.09***	.08	-.08	.10***	.17**	.04	.08***
Backward Digit	.19**	-.01		.24***	.01		.26***	.04		.30***	.07		.20***	.04	
3-RAN	.23**	.13*	.05**	.30***	.17***	.09***	.40***	.30***	.15***	.45***	.36***	.20***	.24***	.18***	.05***
4-OP	.49***	.23**	.19** *	.54***	.26***	.24***	.54***	.35***	.23***	.47***	.22**	.18***	.39***	.18**	.12***
5-PA	.36***	.29***	.06** *	.45***	.39***	.09***	.25***	.19**	.03***	.31***	.24**	.04***	.19**	.09	.02***
6-MA	.24**	.24**	.02**	.19**	.19**	.01**	.19*	.19*	.02*	.26***	.26***	.03***	.32***	.32***	.04***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Dimensionality of reading. The construct of reading in Arabic has never been investigated before. Therefore, the five reading measures used in this study were examined using principal axis factor analysis. This was deemed necessary in order to determine whether the reading measures represented a single construct of reading achievement or multiple constructs in the Grade 3 participants of Phase II in this study. The Kaiser-Meyer-Olkin measure of sampling adequacy was .86, above the recommended value of .6, and Bartlett's test of sphericity was significant ($\chi^2 (10) = 784.06, p < .05$). These results indicate that factor analysis was appropriate. The first eigenvalue was substantial (3.85), much larger than the second (.46) and subsequent eigenvalues. Again, the Scree test method was used to examine the eigenvalue graph and suggested a one-factor solution. As shown in Table 25, all five tests loaded well on this one factor. This solution accounted for 72% of the variance. Regression factor scores were generated from the one-factor solution and the new factor was labelled "Reading factor score." Correlations between the Reading factor score and all of the other variables can be seen at the bottom of Table 12. The Reading factor score correlated significantly with all predictors, cognitive and linguistic, the highest being with PA ($r = .74, p < .01$), followed by OP ($r = .72, p < .01$), and MA ($r = .69, p < .01$).

Table 25

Summary of Reading Measures Principal Axis Factor Analysis

Test	Factor loading
Word Reading	.93
Pseudoword Reading	.78
Word Reading Fluency	.91
Text Reading Fluency*	.86
Comprehension	.74

*Transformed score

Prediction of reading as one construct. Following the finding of reading as one construct, a separate regression model was created to evaluate the role of each of the standard predictors in the overall reading factor (five reading measures combined) as the outcome. Results are reported in Table 26. Similar to the previous regression analyses, the cognitive abilities were entered first, and accounted for 15% of the variance which is comparable to their contribution of 13% in the previous hierarchical regression models (Tables 15 & 16). The other six standard predictors (forward memory, backward memory, RAN, OP, PA, and MA) accounted for an additional 59%, for a total of 74% of the variance accounted for in the model. Recall in the previous hierarchical regression with word reading as the outcome (Table 14), the five predictors accounted for 55%, for a total variance of 68% in word reading. OP again accounted for the most variance contributing 25% of the 74% of the total variance, followed by the MAT and PPVT, both contributing 15%, and the two memory measures contributing 12%. In this regression analysis with reading as the overall construct, PA accounted for 6% of the total variance, which is slightly less than the 9% in the word reading as the outcome (Table 14). On the other hand,

MA's contribution increased from 1% to 3% of the total 74% of variance accounted for in the overall reading model. The weights of the beta coefficients for the standard predictors (RAN, OP, PA, and MA) are all highly significant but very similar to each other in this regression model where the dependent variable is the overall reading factor score. Although OP accounted for the highest variance (25%), and had a substantial beta weight of .56 ($p < .001$) when entered in step. Its beta weight in the final step remained highly significant but dropped in magnitude to .28, which is similar to the beta weights of Naming ($\beta = .26, p < .001$), PA ($\beta = .28, p < .001$), and MA ($\beta = .27, p < .001$). Both memory tests had a highly significant contribution of 12% ($p < .001$). However, their beta coefficients were significant when entered in the model, but not significant in the final model.

Table 26

Hierarchical Regression Model for the Prediction of Overall Reading (Reading Factor Score)

Step	R ²	ΔR^2	Predictor	β^a	β^b
1	.15***	.15***	Matrix Analogies Test (MAT)	.15*	-.07
			PPVT	.30***	.09
2	.27***	.12***	Forward Memory	.17**	-.01
			Backward Memory	.27***	.03
3	.40***	.13***	RAN	.37***	.26***
4	.65***	.25***	Orthographic processing	.56***	.28***
5	.71***	.06***	Phonological Awareness	.36***	.28***
6	.74***	.03***	Morphological Awareness	.27***	.27***

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

^aStandardized beta coefficient for the step at which the predictor first entered the model

^bStandardized beta coefficient for the predictor in the final step of the model

Chapter 5

Discussion

The purposes of this study were: (a) to validate the construct of Arabic morphological awareness; (b) to establish the relationship of MA with word reading and pseudoword reading; (c) to examine the joint and unique effects of a number of standard predictors that contribute to skillful reading in Arabic; and (d) to investigate the nature of the five reading measures in Arabic-whether they represent a single construct or distinct constructs. These objectives were accomplished in two phases with two different samples from Grade 3 Arabic-speaking children in the UAE. In Phase I, morphological awareness tasks were developed, tested with 102 third graders, and validated the construct of MA and its predictive validity of word and pseudoword reading. Phase II investigated the joint and unique effects of a group of standard predictors (PA, MA, OP, RAN, memory, cognitive abilities) on each of the five different reading measures (word reading, pseudoword reading, word-reading fluency, text reading fluency, and reading comprehension) in another sample of Grade 3 UAE children ($N = 201$). Using separate principal axis factor analyses, the construct of MA was examined in both phases. The construct of reading in Arabic was also investigated using five component measures of reading in Phase II. Different sets of hierarchical regression analyses were conducted in both phases to explore the contribution of each of the predictors in each of the reading outcomes. The following discussion provides an interpretation of the results in light of existing literature, and elaborate on the main themes that arise from the findings of this dissertation: the nature of MA in Arabic, the role of each of the standard predictors in reading Arabic, and the nature of the five different reading measures. Accordingly, the discussion will be organized around each question with its prediction(s), and

their interpretation. This chapter also includes sections on: limitations, and future directions and implications for practice.

Research Questions

The *first question* addressed in this study was “*What is the structure (Dimensionality) of Morphological Awareness in Arabic*”? Because Arabic morphology is linear and nonlinear (Boudelaa & Marslen-Wilson, 2010; Abu-Rabia, 2002, 2007, 2012), and the Arabic language is diglossic (Saiegh-Haddad, 2003; 3005), it was predicted that Arabic *Morphological Awareness would be at least bi-dimensional in nature* (e.g., oral versus written or inflectional versus derivational). The first step in answering this first research question occurred in in Phase-I of the study in which a wide range of MA measures based on the taxonomy of Deacon et al. (2008) was developed. Two separate factor analyses were employed, one in Phase I and another in Phase II, to examine the dimensionality of the MA measures. Although it was hypothesized that MA in Arabic would be multidimensional, the results of both MA factor analyses yielded a unidimensional MA factor suggesting that MA knowledge in Arabic is essentially one-dimensional. Interestingly, in spite of the diversity of morphological measures used, the complexity of Arabic’s linear and non-linear morphology and the diglossic phenomenon of Arabic, the morphological measures used in this study appear to represent a single construct.

Two interpretations are offered for this current finding on the unidimensionality of MA in Arabic. First, it could be argued that in spite of the differences between Standard Arabic and Spoken Arabic, there are shared similarities between both codes. For example, in Standard Arabic the word /nadrusu/ “we study” is /nudrus/ in spoken local Arabic. Both words although having phonological differences, share the same root (**d.r.s**), which is the most salient feature of the Arabic lexical structure. Moreover, both words in this given example share the same

inflectional marker for first plural pronoun /n/ to denote “we.” These shared factors may have played a role in the finding of the unidimensionality in Arabic. Future research is needed to investigate the similarities between Standard Arabic and Local Arabic, in a similar vein to the studies on the linguistic differences between both codes. The second interpretation may lend support to the saliency of the root in Arabic. In other words, whether MA tasks required composition or decomposition processes, inflection or derivation, have syntactic cues or not, the basic building block in all of these processes is the root– even more than the word pattern due to its semantic component. Hence all possible dimensions of Arabic morphology will reside in the root. This interpretation can be supported by the empirical evidence (reviewed in the literature) on the supremacy of the root in several priming studies by Boudelaa and his colleague (Boudelaa & Marslen-Wilson, 2005, 2011, & 2011).

This finding of the unidimensionality of MA in Arabic third graders is consistent with the two studies reviewed above that reported on the unidimensionality of MA (Muse, 2005; Spencer et al., 2015). In contrast, findings from the current study diverged from those of Tighe and Schatschneider’s (2015) research that found MA split into two dimensions, one for real words and another for pseudowords in adult participants. Consequently, future studies on Arabic MA dimensionality should include a measure of MA with pseudowords across several grades in order to further examine the dimensionality of the Arabic MA construct. It is acknowledged that Arabic and English have very different orthographies precluding direct comparisons between the languages. However, it is instructive to make such comparisons for heuristic purposes when specific orthographic patterns or rules exist in one language and not another.

In addition to the contribution of this finding to the cross-linguistic study of MA, the unidimensionality of the Arabic MA tasks suggests that practitioners should feel confident in

using a restricted number of MA measures for both clinical and experimental purposes. However, this finding could be challenged in future research in which MA tasks in Arabic are studied longitudinally or cross-sectionally with a range of ages. It is quite possible that in younger Arabic-speaking children, MA tasks prove to represent more than one factor given the differences in the oral and written forms of the Arabic language due to the diglossic nature of Arabic, as well as absence of formal instruction in standard Arabic-in the preschool years. Multiple dimensions of MA may also emerge with older Arabic readers who have mastered reading. This could possibly be due to the fact that skilled readers employ other strategies such as their increased knowledge of standard Arabic vocabulary, or syntactic awareness especially when MA tasks are designed at the sentence level. These possibilities could be examined and challenged in future research on Arabic MA dimensionality.

Furthermore, given a plethora of cross-linguistic research underscoring the importance of assessing separate component skills of reading achievement in struggling readers, it would be productive to replicate the current study with Arabic-speaking children who have specific language disabilities such as dyslexia. It is possible that for individuals with dyslexia, performance on MA tasks may vary depending on the degree of semantic information required to accomplish the tasks (i.e., real versus pseudowords).

The ***second question*** was “*What are the contributions of the predictor variables of phonological awareness, orthographic processing, morphological awareness, naming, and vocabulary to individual component skills of reading*”? Overall, it was predicted that *phonological awareness (PA) would contribute the most variance of all predictors to vowelized word reading in Arabic because vowelized Arabic is highly transparent, and that orthographic processing (OP) will contribute the most variance of all predictors to word-reading fluency*

because of the complexity of Arabic orthography. Different predictions were suggested for each of the standard of predictors of interest in this study and separate sets of regression analyses were undertaken to examine the independent contributions of PA and OP to component skills of reading. Results from the current study of Arabic Grade 3 children lend complete support to the roles of PA and OP in reading as expected from previous studies showing that PA and OP are the two strongest and most widely established predictors of overall reading ability. Specifically, OP accounted for more unique variance than PA for all reading outcomes. It should be noted that: (a) PA was entered after OP in the model, and more importantly; and (b) the beta weight of PA when entered in the last step was more substantial than that of OP for both word-level reading and pseudoword reading. Overall, comparable robust roles for both, OP and PA in reading were found for the population studied. The strength of the contributions of these two constructs support both Share's (1995) self-teaching hypothesis and Ehri's (1995) phase model on reading development which address the importance of both, phonology as well as orthography.

When comparing the respective contributions of PA and OP constructs and specific non-reading variables to component skills of reading, PA was found to be more significant than RAN in predicting word and pseudoword reading, whereas RAN played a more significant role in predicting timed reading measures, particularly text-reading fluency. These findings are consistent with other studies on Arabic reading (Abu-Ahmad et al., 2013; Abu Rabia, 1997, 1999, 2001; Taibah & Haynes). Interestingly, findings from the current study show that PA contributed significantly and comparably to both word reading and pseudoword reading. As expected, PA's contribution was least robust for the component skill of reading comprehension due to the strong associations reported between reading comprehension and semantic dimensions of language such as vocabulary. Similar to PA, OP accounted for a unique significant variance

for all reading component outcomes with its strongest contribution to word-reading fluency. Considering that OP allows for processing letter strings, mainly the roots in Arabic, or the whole word as one unit (Ehri, 1997), it is not surprising that OP would affect word-reading fluency. The strong role of OP in reading fluency in this sample of Arabic-speaking children is consistent with the role of OP in reading in other shallow orthographies such as Korean (Kim, 2015) or Persian (Rahbari et al., 2007). Furthermore, data from several much earlier studies showed that naming speed predicts orthographic processing (e.g., Bowers, 1995; Bowers & Wolf, 1993; Manis et al., 1999).

Two factors may play a key role in the robust contribution of both PA and OP in this sample of Arabic-speaking children. First, the instructional reading methods used by teachers could account for the prominent role of OP, however, this cannot be addressed here because no single instructional method for teaching reading is adopted in the schools in the UAE (see Tibi & McLeod, 2014; Tibi et al., 2013). In the present study, it was also evident from few classroom observations that teachers used varying degrees of decoding and sight-word reading instruction which converged with findings by Tibi et al. (2013). Second, the high degree of grapheme-phoneme correspondences in a shallow orthography such as Arabic results in less divergence between orthographic conventions and phonetic transcriptions than in a more opaque language such as English (Chomsky, 1970).

Consistent with the literature reviewed in this study on WM, findings of the current study showed significant correlations between WM and all other predicting variables, the highest being ($r = .44, p < .01$) with phonological awareness. WM also accounted for unique variance in all component reading skill outcomes (range 7–12%). However, its final beta once all other variables were entered in the final step dropped and was no longer significant for any of the

reading outcomes. This finding is consistent with the conflicting evidence on the role of WM in the reading literature on Arabic. While Saiegh-Haddad (2005) reported that WM is the second primary predictor of pseudoword reading fluency after letter recoding speed, Abu-Ahmad et al. (2013) reported a marginal and nonsignificant contribution of WM. They suggested that their findings may be due to the few items their task included and the task's low reliability score of .65. Similar to Abu-Ahmad et al., the current study reported a reliability of .67 and included 21 items on its backward digit span.

It is important to note that the digit span (forward or backward) repetition task may be more difficult to perform in Arabic than in English, because Arabic words for digits are mostly bi-syllabic and tri-syllabic words, compared to the monosyllabic English equivalent, hence requiring a great memory load. Perhaps future research could employ another measure of WM. Nevertheless, with the current backward digit span measure, WM was shown to have moderate significant correlations also with all reading measures (range .30 - .40, $p < .01$), the highest with text-reading fluency. The role of WM in text-reading fluency was also evident in the current study in its unique variance of 10% with a substantial beta coefficient of .30 ($p < .001$) when entered in the second step after controlling for verbal and nonverbal abilities. This is in accordance with what Wolf and Bowers (1999) noted on the role of WM as a coordinator between OP and PA in word recognition.

The *third predictor* within the second research question was that *Morphological Awareness (MA)* would contribute to a broad range of reading measures, and will explain unique variance in reading comprehension above and beyond that of other predictors-including control for word reading. Results showed that MA played a central role in all reading outcomes, with its largest effect in reading comprehension, and accounted for a significant and unique variance,

even when it was entered last in all models. Its contribution, although small ranging from 1-4%, was evident after the controls of all possible predictors. The integrative role of MA in reading words, pseudowords, word-reading fluency, text-reading fluency, and reading comprehension deserves more recognition than previously given in all developmental reading models, particularly in future Arabic reading models. While it may seem intuitive that morphology is part of vocabulary, findings from the current study, as well as previous studies in English (e.g., Berninger et al., 2010; Kirby et al., 2012; Nagy 2007; Stahl & Nagy 2006) confirm that MA contributes to reading after controlling for vocabulary. Also, there is growing empirical evidence for the robust role of morphology in several languages, Semitic, Indo-European, and logographic, as well as in orthographies that differ in their degree of depth (opaque versus transparent) (Carlisle, 2000; Kirby et al., 2012; Ravid & Malenky, 2001; Tong, McBride-Chang, Shu, & Wong, 2009).

Based on findings from the current study, in addition to the substantial empirical evidence in other languages, morphology is indeed an independent and powerful piece in the puzzle of Arabic reading. Current findings showed also that MA accounted for a unique variance in both reading speed measures. This is in conjunction with previous research on the role of MA in reading fluency (Kirby et al., 2012; Pittas & Nunes, 2014). Text-reading fluency shares with comprehension the aspect of meaning, and morphology seems to play a key role in both types of reading (reading comprehension and text fluency). The fact that MA survived the controls of PPVT, nonverbal ability, and other key predictors such as word- and text-reading fluency suggests that MA plays an independent role in reading in Arabic. The feature of letter chunks (roots in the case of Arabic) allows for fluent reading because (a) words have fewer morphemes than graphemes, and the semantic feature carried by the consonantal root enhances

comprehension; and (b) the same consonants of each root must recur in any of the root's derived words, hence, increasing its orthographic redundancy. Clearly, MA in Arabic not only refines meanings, but also allows for new meanings that share characteristics with roots.

It is not surprising that targeting MA in intervention studies with undifferentiated and dyslexic children (Bowers et al., 2010; Elbro & Arnbak, 1996; Goodwin & Ann, 2013; Quémart & Casalis, 2015) has been shown to have a positive effect on reading skills. Considering the central role of MA in word formation, reading accuracy, reading fluency and its independent contribution to reading comprehension, it calls for the necessity to include it in all language assessment tools, as well as in formal reading instruction. Clearly, MA in Arabic should be a key area for intervention that impacts word recognition, comprehension, and spelling.

Overall, findings from this study confirm Berninger et al.'s (2010) conclusion about the importance of the three linguistic awareness skills (PA, OP, and MA) and the need to coordinate these three skills in reading instruction in order to optimize learning. The fact that the sequence of the letters of the roots is regular in Arabic in the sense that these consonants would always appear in their corresponding derivatives in their respective order (e.g., the three consonantal root [k.t.b] will always have its three consonants appearing in all of its derivatives: /kataba/, /kat.ta.ba//kutub/, /kita:b/, maktab/, maktaba/, /maktu:b/, /kata:ti:b/, etc..) underscores the importance of orthographic awareness. Yet, this function of OP within the root morphemes does not seem to prevent MA from contributing independently to word reading, reading fluency, and more importantly to comprehension. Findings of this study clearly shed the light on the role of each of these three linguistic skills. Using a music analogy, it seems that the three instruments, PA, OP, and MA each plays its own music, but together contribute to the harmony of the piece (reading).

The *fourth prediction* in the second research question was that *RAN plays a significant role in text reading fluency and in reading comprehension above that predicted by word reading fluency* based on previous literature showing that naming speed is a significant predictor of reading fluency especially in consistent orthography. As discussed above, there is considerable evidence for role of rapid automatized naming (RAN) (or naming speed) in reading (Georgiou et al., 2008; Kirby et al., 2003; Kirby et al., 2010) and reading disability (Morris et al., 1998; Scarborough, 1998; Wolf & Bowers, 1999).

RAN has been shown to correlate strongly with different reading measures, particularly with speeded measures of reading—more than reading accuracy (Papadopoulos et al., 2009; Savage & Fredrickson, 2005). Its robust contribution has been reported in a number of predictive studies where researchers found that RAN survives established controls such as cognitive abilities, PA, MA, and word reading fluency (Georgiou et al., 2009, Kirby et al., 2009; Roman et al., 2009), supporting the hypothesis that RAN is a distinct construct from other predictors. Consistent with previous research on the robust role of RAN, data from this study revealed that RAN correlated more strongly with text-reading fluency ($r = .51, p < .01$) and word-reading fluency ($r = .45, p < .01$), rather than with the reading accuracy measures ($r = .29-.37, p < .01$). This finding is in accordance with findings from research on different consistent orthographies (Dutch: de Jong & van der Leij, 1999; German, Landerl & Wimmer, 2008; Greek, Georgiou et al., 2008; Finnish, Lepola, Poskiparta, Laakkonen, & Niemi, 2005).

Further, and most importantly, RAN made unique contributions to all reading outcomes above and beyond all other important predictors, including the robust predictors of word-reading fluency and OP. Interestingly, even when word-reading fluency— a requisite of text fluency— was controlled for, RAN remained powerful and accounted for variance in text-reading fluency. In

the current study, RAN contributed significantly to text-reading fluency confirming: (a) the importance of speeded naming/recognition of items (words) in text reading fluency; and (b) the fact that RAN shares with text reading some processes such as sequencing and continuity.

RAN was also found to contribute to reading comprehension accounting for 2%, and surviving the control of the established predictors of cognitive abilities (MAT & PPVT). RAN also survived the controls of PA and OP. There are significant implications in its role in comprehension. First, automaticity in word recognition is essential for comprehension. Second, efficient reading does release some cognitive load, hence allowing for cognitive resources (e.g., working memory) to be allocated to comprehension. Indeed, RAN's pervasive role in all reading outcomes, specifically in text-reading fluency- is evident in the present findings, particularly because it withstood robust predictors such as MAT, PPVT, OP and PA, even when it was entered last.

The ***third research question*** addressed in this study was “*What is the nature of the reading construct in Arabic*”? The construct of reading was never investigated before in the research on reading in Arabic. In fact, very few studies have examined the construct of reading in English as reviewed in the literature of the current study. Therefore, the present study is a beginning step in this direction. The results of exploratory factor analysis suggest that the five measures come together under one factor. Although the five measures all tap into reading, the measures are generally treated separately due to their use to detect individual differences among normal readers or certain deficits among children with reading difficulties (Aaron et al., 1999; Bishop & Snowling, 2004; Bowey, 2005; Cain et al., 2004; Catts et al., 2015; Lombardino, 2012; Nation & Snowling, 2000). Thus the one-factor solution for the reading measures found in the current study is a finding that should be interpreted with caution for the following reason. In

the past, a child's overall reading achievement score was used to determine if the child had a reading disability. We know that the use of a single score is inadequate because some children score poorly simply because they have not had adequate exposure to literacy instruction and some children who have reading disabilities score well enough on comprehension measures with an overall rating achievement score within the range of normal (Shaywitz, 2003). This is frequently the case with bright children who have dyslexia (Stanovich, 1988a, 1988b). Looking at component skills allow us to see if there is a primary area of deficit as in dyslexia, or if all aspects of language are compromised. Without examining component skills of reading, we will not be able to determine the nature of the reading difficulty and the type of intervention needed. We are most likely to miss out on the early identification of children who may be at-risk for reading difficulty or actually have some type of reading disabilities. Moreover, the unidimensionality of Arabic reading certainly should not be generalized to children in the upper grades when they read unvowelized orthography. Similarly, findings should not be generalized to different populations where there might be other sociolinguistic factors such as bilingualism, or differing methods of instruction at this time. Given that this study was the first time that these reading measures were used with an Arabic sample, future studies using these Arabic measures coupled with confirmatory factor analysis are needed to determine whether a one-factor or five-factor model is the best model for Arabic populations.

There is no doubt that when put simply, reading is *reading*. Therefore, the strong correlations between the five reading measures in the current study are meaningful. In fact, Scarborough (1998) and numerous studies (e.g., Fuchs et al., 2001; Kim, 2015; Kim et al., 2011, 2012; Kirby et al., 2012) in reading research involving typically and atypically developing children have shown that component skills (word reading and decoding or decoding and

comprehension or fluency and comprehension) of reading are moderately to highly correlated. However, in spite of evidence for strong links between the reading measures, more recent research has confirmed that the reading speed constructs (i.e., word-reading speed and text-reading speed) and reading comprehension are indeed separate constructs (Catts et al., 2006; Keenan et al., 2008; Kim et al., 2011, 2012, 2014; Kim & Wagner, 2015). For the Grade 3 children in this study all reading skills clustered as single factor, because children have not mastered reading yet. It could be the case that the participants in this study still use some decoding strategy to attain comprehension. With older participants, reading is expected to become more automatic, and comprehension will no longer be solely dependent on decoding. In fact, research has confirmed the subtype of poor comprehenders (Catts et al., 2006; Elwér et al., 2013; Li & Kirby, 2014; Nation & Snowling, 2000). In such a case, it will not be odd to find that reading accuracy (decoding), reading fluency, and reading comprehension constitute separate constructs.

It is legitimate to suggest that even in cases where reading measures loaded on one factor, data of this nature do not provide conclusive evidence that each measure represents the full construct of “skilled reading” as defined by age-appropriate reading comprehension. As noted in the literature review of this study, reading comprehension measures do indeed tap different skills with some relying more on decoding, while others rely on comprehension strategies. Perhaps, the type of reading comprehension measure (maze comprehension) used in this study affected the finding of the unidimensional nature of the reading construct. Research (Keenan et al., 2008; Nation & Snowling, 1997) has informed us that the reading comprehension tests that include short passages or single sentences and require a choice of word-from three given words- to finish (cloze) the meaning of the sentence does in fact tap word decoding (e.g., I saw a _____ at the

zoo. The choices are “graffiti, giraffe, grab”). The maze test in the current study did include short passages with blank spaces. The participant had to choose the correct answer from a choice of three given words. In such a test, the participant had to decode the three given words accurately in order to be able to derive the correct answer. Had there been another reading comprehension test that taps prior knowledge or requires a short answer, results could have been different. This, however, remains to be investigated.

Findings from this study offer insight into the factors that contribute independently to reading in Arabic among Grade 3 children. Overall, the results indicate that phonological awareness, orthographic awareness, rapid speeded naming, and morphological awareness all offer unique variance in reading in Arabic. The contribution of each predictor is differentiated by the reading outcome. Of particular interest is the role of morphological awareness in all reading outcomes. Although MA accounted for a small unique variance (range 1–4%) in the different reading outcomes, its contribution is of value, because it remained significant after controlling for other linguistic and cognitive factors. Moreover, MA contributed a unique variance to reading comprehension after controlling for word reading, word-reading fluency, and text reading-fluency indicating that MA plays a central role in reading comprehension in Arabic. The independent contribution of MA above and beyond stringent factors (such as PA and OP) bolsters its significant role in the lexical architecture of Arabic reading, and confirms its empirical separability as a construct from OP and vocabulary, each of which made their own independent contributions.

In summary, the complex skill of reading is comprised of individual component skills that differentially predict reading at varying stages of reading skills. Existing literature on reading acquisition and development along with developmental and componential models of reading are

replete with evidence supporting the multidimensional aspects of reading. The current study provides additional support for differential impact of core reading skills on the act of reading comprehension and highlights the central role of MA in reading Arabic.

Limitations

The limitations of this study are addressed below, each of which should be addressed in future studies. First, only one measure for each reading outcome variables was used to assess the children's skills. The use of at least two measures for each component reading skill would help to determine, with greater confidence and precision, whether component reading skills load on a single reading factor or show separate constructs. In the current study with Grade 3 children, the five component reading skill outcome measures loaded on one factor, yet relationships between widely studied predictor variables (e.g., phonological, morphological and orthographic awareness) differed across component reading skill measures. In light of Kim's (2015) recent longitudinal study showing that the reading word-reading fluency, text-reading fluency, and reading comprehension represent three different constructs in spite of their strong link to each other, it is quite possible that predictor-outcome relationships could differ at various stages in the development of reading Arabic.

Second, another important limitation of this study was a lack of data on teachers' specific instructional methods for teaching Arabic reading. Instructional methods can impact children's phonological, morphological and orthographic awareness in addition to their word and text-level reading. Third, this study sampled children from only one Arabic country. Given the diversity of spoken Arabic dialects across the entire Arabic-speaking countries in Asia and North Africa, populations of Arabic-speaking children from other regions should be sampled. This will inform our understanding of the diglossic impact on different reading outcomes. Fourth, it could prove

to be quite informative to include the assessment of dimensions of spoken and written language that were not addressed in this study such as syntactic awareness and spelling knowledge. Including a measure of syntactic judgment may shed light on more complex relationships between spoken language and reading comprehension. Further, the assessment of spelling knowledge may predict more complex relationships between this dimension of orthography and morphological awareness. Finally, although this study included a wide range of MA measures, MA needs to be studied employing different techniques such as priming and response time measures. Priming paradigms provide a powerful tool for manipulating the temporal course in activating the distinct types of representations (morphological versus orthographic) in a lexical decision task. The accuracy and consistency in the durations selected can only be obtained through the priming software with a high degree of reliability.

Future Research and implications for Practice

This study provides the impetus for three key areas of future research specific to Arabic-speaking children: (a) using a wide range of assessment tools with high reliability indices; (b) investigating reading development through longitudinal research; (c) employing other statistical analysis (e.g. structural equation modeling); (d) analyzing children's reading and MA and reading errors; and (e) conducting intervention research. Each of these potential areas for research will be addressed in the following sections.

Future research could benefit from the different tools developed and validated in this study, particularly the word reading measures, MA, OP, PA, and the translated PPVT. All these tools developed and tested in this study have high reliability estimates and can be used with other populations because the tools were developed in Standard Arabic, which is the common language in all Arab countries. Second, longitudinal data may reveal different types

of (inter)relationships between predictors and outcomes. Hence, allowing us to understand the individual differences as a consequence of development. For example, how results may change if the same reading stimuli were presented without vowelization (opaque orthography) for children in the upper grades? Would the same predictors hold? Furthermore, future research regarding the direction of causality between MA, for example, and different reading outcomes is needed to inform instruction and remediation efforts.

Future research using data from this study will be undertaken to analyze children's reading and morphological errors from the current study. All children's oral errors were documented and transcribed in the International Phonetic Alphabet (IPA) system by the researcher. As for the written errors, all are kept on record. Patterns of errors, and whether the errors are more morphological or phonological in nature, will be investigated. Unfortunately, research on analyzing reading errors in Arabic is limited to one or two studies that focused mainly on phonological errors and neglected the aspect of morphology. Analyzing the type of errors will inform us about the nature of the error if it is in the phonological or the morphological domain, or if it is due to the orthographic aspect such as similar shared letters. Such analysis will help shed light on the characteristics of reading disorders as well as the processes manipulated by the young Arabic readers. It could also inform us about the possible different subtypes of reading difficulties in Arabic.

The completion of intervention studies will bring more clarity on the roles of PA versus MA, particularly that intervention research on Arabic reading is meagre. A clear implication from these results is that conducting intervention studies with a focus on morphological instruction is of central value, because morphology is a fundamental feature of the Arabic language lexical structure. The unique role MA plays in the different reading outcomes (word

reading, reading fluency, and comprehension) clearly suggests that children's MA should be developed in a systematic and explicit way. Research should investigate the effects of morphological awareness on children's reading across different grades. Another implication from the current results is the need for including MA measures in all language and reading assessment tools, especially in the early grades.

The results also provide a framework for researchers interested in pursuing studies in the morphological processes of the Arabic language. Given the relatively strong relationship between MA and word reading, measures of MA should be included in predictive studies so that a more complete picture of linguistic strengths and weaknesses can be obtained. Building on the current findings will help us deepen our understanding of morphology's effects and help us refine the tools further for different age groups. The findings have theoretical and practical implications for assessment and intervention in regular classrooms as well as in the field of special education. This study is the first of its kind to include a large number of tests covering several reading and reading-related measures with Arabic speaking children. Results of the current study a) informed us about the cognitive processes involved in reading Arabic; b) shed light on the role of each variable and its significance; and c) would aid in validating the tools developed in this study, particularly in the absence of any Arabic standardized measures. Furthermore, children at risk for reading failure in Arabic will benefit from explicit instructional programs that target significant predictors of literacy.

For educators, two applications arise. First, assessment of morphological awareness should be included in any language or early reading assessment. Teachers and speech-language clinicians need to give this area more attention in their assessments. The second application would be in instruction. The strong association between MA and reading suggests that it may be

a useful target for instruction; this would be supported by instructional studies in other languages (see Bowers et al., 2010, Carlisle, 2010, and Goodwin & Ahn, 2013, for reviews). Instruction programs explicitly targeting MA in Arabic are sorely needed. Considering the important role morphology has in Arabic word construction and the present results, it seems very likely that enhanced morphological knowledge would exert a powerful positive influence on literacy achievement in Arabic. One barrier for both researchers and educators is the lack of standardized tools of reading and reading-related processes in Arabic, even though all Arab countries share the same Standard form of the language. The development of such tools should be seen as a priority for policy makers in the Arab world.

This study offers a basis for further research on the morphological and other linguistic and cognitive processes involved in reading Arabic. The construct and predictive validity of MA as demonstrated in the current study should trigger more research in the field of Arabic reading and morphological processing, particularly with children learning to read. Moreover, the distinctive features of the Arabic language (phonology, orthography, and morphology) also offer opportunities for researchers to conduct cross-linguistic research to broaden their understanding of language and literacy in a more global context.

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Appendix A

Ethics Documents



March 13, 2013

Mrs. Sana Tibi
Ph.D. Candidate
Faculty of Education
Duncan McArthur Hall, Room A106
Queen's University
511 Union Street
Kingston, ON K7M 5R7

GREB Ref #: GEDUC-662-13; Romeo # 6007828
Title: "GEDUC-662-13 Morphological awareness and reading in Arabic"

Dear Mrs. Tibi:

The General Research Ethics Board (GREB), by means of a delegated board review, has cleared your proposal entitled **"GEDUC-662-13 Morphological awareness and reading in Arabic"** for ethical compliance with the Tri-Council Guidelines (TCPS) and Queen's ethics policies. In accordance with the Tri-Council Guidelines (article D.1.6) and Senate Terms of Reference (article G), your project has been cleared for one year. At the end of each year, the GREB will ask if your project has been completed and if not, what changes have occurred or will occur in the next year.

You are reminded of your obligation to advise the GREB, with a copy to your unit REB, of any adverse event(s) that occur during this one year period (access this form at https://eservices.queensu.ca/romeo_researcher/ and click Events - GREB Adverse Event Report). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours.

You are also reminded that all changes that might affect human participants must be cleared by the GREB. For example you must report changes to the level of risk, applicant characteristics, and implementation of new procedures. To make an amendment, access the application at https://eservices.queensu.ca/romeo_researcher/ and click Events - GREB Amendment to Approved Study Form. These changes will automatically be sent to the Ethics Coordinator, Gail Irving, at the Office of Research Services or irvingg@queensu.ca for further review and clearance by the GREB or GREB Chair.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

A handwritten signature in cursive script that reads "John D. Freeman".

John Freeman, Ph.D.
Professor and Acting Chair
General Research Ethics Board

cc: Dr. John Kirby, Faculty Supervisor
Dr. Don Klinger, Chair, Unit REB
Erin Wicklam, c/o Graduate Studies and Bureau of Research



August 06, 2014

Mrs. Sana Tibi
Ph.D. Candidate
Faculty of Education
Queen's University
Duncan McArthur Hall
511 Union Street West
Kingston, ON, K7M 5R7

Kingston, ON K7L 4N3

GREB Ref #: GEDUC-736-14; Romeo # 6013236

Title: "GEDUC-736-14 Cognitive and Linguistic Factors in Learning to Read Arabic Among Grade 3 Students"

Dear Mrs. Tibi:

The General Research Ethics Board (GREB), by means of a delegated board review, has cleared your proposal entitled **"GEDUC-736-14 Cognitive and Linguistic Factors in Learning to Read Arabic Among Grade 3 Students"** for ethical compliance with the Tri-Council Guidelines (TCPS) and Queen's ethics policies. In accordance with the Tri-Council Guidelines (article D.1.6) and Senate Terms of Reference (article G), your project has been cleared for one year. At the end of each year, the GREB will ask if your project has been completed and if not, what changes have occurred or will occur in the next year.

You are reminded of your obligation to advise the GREB, with a copy to your unit REB, of any adverse event(s) that occur during this one year period (access this form at https://eservices.queensu.ca/romeo_researcher/ and click Events - GREB Adverse Event Report). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours.

You are also reminded that all changes that might affect human participants must be cleared by the GREB. For example you must report changes to the level of risk, applicant characteristics, and implementation of new procedures. To make an amendment, access the application at https://eservices.queensu.ca/romeo_researcher/ and click Events - GREB Amendment to Approved Study Form. These changes will automatically be sent to the Ethics Coordinator, Gail Irving, at the Office of Research Services or irvingg@queensu.ca for further review and clearance by the GREB or GREB Chair.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

Joan Stevenson, Ph.D.
Chair, General Research Ethics Board

c: Dr. John Kirby, Faculty Supervisor
Dr. Christopher DeLuca, Chair, Unit REB
Ms. Stacey Boulton, c/o Graduate Studies and Bureau of Research

Project title: Morphological Awareness and reading in Arabic

Recruitment:



The following letter will be sent to the head of Research Ethics Board at Abu Dhabi Education Council (ADEC) who will share with the principals of the participating schools.

To: Dr. Badri/ Chair of Research at Abu-Dhabi Education Council,

My name is Sana Tibi and I am a doctoral student in Cognitive Studies under the supervision of Dr. John Kirby from the Faculty of Education at Queen's University, Ontario, Canada. I am writing to seek the permission of the Abu Dhabi Educational Council (ADEC) have access to public elementary schools, Grade 3 in particular, and be able to conduct my research. My research study is about assessing morphological awareness of Arabic-speaking children in order to help me understand more fully reading development and its failures in the Arabic language. The role of morphology in Arabic reading has not been widely studied. The morphological tasks will include a variety of measures to cover both the derivational and inflectional aspects of Arabic morphology and will entail different dimensions (production, judgment, reading, and writing). The tasks will require saying, reading, and writing single words in addition to naming some pictured items. I will supply you with a copy of all testing materials if you wish. In order to conduct the study, I need to assess 100 children (50 boys & 50 girls) on a number of reading measures. To carry out the assessment, I will need to meet with each child individually two times. Each meeting will take approximately 40 minutes in a safe and quiet place recommended by the principal in the school where the participating children will be tested. No one will have access to these data except my supervisor and myself.

A letter of information explaining the purpose of the project and the procedure to take place along with a consent form will be provided to the parents prior to the beginning of the assessment procedures. Only parents who sign the consent forms will have their children participating in the study. In the letter of information as well as the consent form, contact details of the Graduate Research Ethics Board, my supervisor and myself will be provided. Parents will be able to contact any of these parties should they wish to inquire about specific information.

I will be glad to give a workshop on Arabic literacy to all elementary Arabic language teachers in each of the public schools to which you grant me access. If you have any questions about the study, please feel free to contact me at s.tibi@queensu.ca or my supervisor Dr. John Kirby at kirbyj.@queensu.ca or at (613-533-6000), ext. 77231.

Thank you very much for your consideration.

Sincerely,
Sana Tibi

Letter of Information

This letter of information will be translated into Arabic

Project title: Morphological Awareness and reading in Arabic



Dear Parents,

I am writing to ask your permission for your child to participate in a research study. This research is being conducted by Sana Tibi, a doctoral student, under the supervision of Dr. John Kirby, in the Faculty of Education at Queen's University in Kingston, Ontario, Canada. *This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen's University policies.*

The purpose of this study is to develop measures of morphological awareness for Arabic-speaking children, in order to help us understand more fully reading development and its failures in the Arabic language. The study will require two individual meetings with your child and each meeting will take 40 minutes. Your child will be tested at a time in the day recommended by the teacher to minimize impact on classroom activities. There are no known physical, psychological, economic, or social risks associated with this study.

As stated above, I will meet with your child two separate times for 40 minutes each time to administer some reading and writing tasks. In each task, your child will see words, sentences, or pictures (for instance a picture of a car or cars), and be asked to answer different types of questions. For example, I will show your child some words or pictures (car, cars, cats), and ask your child to select the appropriate answer from a choice of three words. Another example would be to provide a word that would best complete a sentence with a missing word. All the tasks will be similar to what your child does in any Arabic language class.

Your child's participation in this study is completely voluntary. Although it would be greatly appreciated if your child participates in the study, you should not feel obliged to have your child participate in this study; there are no consequences for not participating. Your child may also withdraw at any time with no effect on his/her standing in school. Your child has the right to inform the researcher that s/he does not wish to participate in the testing. You can also email the researcher if you do not want your child to continue with the testing. Should you decide to withdraw your child from the study, you may request removal of all or part of your child's data. Your child will be tested in a quiet place in the school during the months of May and June, 2013, or during the summer camps associated with school in the months of July and August, 2013. I will ask your child's classroom teacher about your child's exact date of birth and if Arabic is your child's first language.

Your child's responses will be kept confidentially. I will not use your child's name or any information that would allow the child to be identified. Only my supervisor and I will have access to this information. The results will be published in my doctoral thesis, and may also be published in professional journals or presented at scientific conferences. Any such publications or presentations will be of general findings and no individual child will be able to be identified in any publication. The data will be kept in a locked room, and that data files will be kept on password-protected computers. Data will be retained indefinitely, for later analysis. If data are used for secondary analysis they will contain no identifying information.

Although your child will not benefit directly from the study, I hope to learn more about how children read Arabic, and I hope that what is learned as a result of this study will help us to better understand Arabic reading and how to develop Arabic reading books and teaching materials based on sound research. If you wish to receive a summary of the findings, please provide your e-mail address on the Consent Letter; we will send you a copy of these findings when the study is complete.

Any questions about study participation may be directed to the research investigator, Sana Tibi at (s.tibi@queensu.ca) or to my supervisor, Dr. John Kirby at 613-533-6000, ext 77231 or (kirbyj@queensu.ca). Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at chair.GREB@queensu.ca or 613-533-6081.

Thank you.
Sincerely,
Sana Tibi

Consent Form

This consent form will be translated into Arabic

Project title: Morphological awareness and reading in Arabic



Please read the following, sign at the bottom, and return the form to your child's classroom teacher. Retain the second copy for your records.

1. I have read the Letter of Information and Consent form and have had any questions answered to my satisfaction.
2. I understand that my child will be participating in the study called *Morphological awareness and reading in Arabic*. The purpose of this study is to develop measures of morphological awareness (MA) for Arabic-speaking children, in order to help us understand more fully reading development and its failures in the Arabic language. I understand that this means that my child will be asked to read some words, point to some pictures, and complete short sentences which all will be similar to what my child does in any Arabic language class. The total time for answering the questions will be 80 minutes divided over two sessions of 40 minutes each.
3. I understand that my child's participation in this study is voluntary and my child may withdraw at any time with no effect on his or her standing in school. My child has the right to inform the researcher that s/he does not wish to participate in the testing. As a parent, I also have the right to email the researcher if I do not want my child to continue with the testing. Should I decide to withdraw my child, I may request removal of all or part of my child's data. I understand that my child will be tested in a quiet place in the school during the months of May and June, 2013, or during the summer camps associated with school in the months of July and August, 2013. I also understand that you will be asking my child's classroom teacher about my child's exact date of birth and if Arabic is my child's first language.
4. I understand that my child's responses will be kept confidentially. You will not use my child's name or any information that would allow my child to be identified. Only the researcher (Sana Tibi) and her supervisor (Dr. John Kirby) will have access to the data. The results will be published in her doctoral thesis and may also be published in professional journals or presented at scientific conferences. Any such presentations will be of general findings and no individual child will be able to be identified.
5. If you wish to receive a summary of the findings, please provide your e-mail address below; we will send you a copy of these findings when the study is complete.

I am aware that if I have any questions, concerns, or complaints, I may contact Sana Tibi at s.tibi@queensu.ca or her supervisor, Dr. John Kirby at 613-533-6000, ext 77231 or at kirbyj@queensu.ca; or the Chair of the General Research Ethics Board at 613-533-6081 at Queen's University or chair.GREB@queensu.ca.

I have read the above statements and freely consent that my child participates in this research:

Please sign one copy of this Consent Form and return to the teacher. Retain the second copy for your records.

Name of Child: _____

Name of Parent (please print clearly): _____

Signature: _____

Date: _____

To receive a summary of the findings, provide your e-mail address:

Letter of Information

This letter of information will be translated into Arabic

Project title: Cognitive and linguistic factors in learning to read

Arabic among Grade 3 students



Dear Parents,

I am writing to ask your permission for your child to participate in a research study. This research is being conducted by Sana Tibi, a doctoral student, under the supervision of Dr. John Kirby, in the Faculty of Education at Queen's University in Kingston, Ontario, Canada. *This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen's University policies.*

The purpose of this study is to understand the factors that contribute to reading among Arabic-speaking children, in order to help us understand more fully reading development and its failures in the Arabic language. Your child will be tested at a time in the day recommended by the teacher to minimize impact on classroom activities. There are no known physical, psychological, economic, or social risks associated with this study.

I will meet with your child individually two separate times for 25 minutes each time to administer some individual reading and writing tasks. In each task, your child will see words, sentences, or pictures, and be asked to answer different types of questions. For example, I will show your child some words or pictures (car, cars, cats), and ask your child to select the correct answer from a choice of three words. Another example would be to ask your child to provide a word that would best complete a sentence with a missing word. Most of the tests will include language and reading tasks similar to what children do in their Arabic-language class. In these tasks, the child will see and read words, pseudowords, sentences, or pictures, and be asked to answer different types of questions. Your child will also be tested in group on the Matrix Analogies nonverbal test (25 min), and will be given clear instructions and examples to clarify the process of choosing the geometric shape from 3-4 choices to complete a specific geometric design. Furthermore, your child will also be tested in group in another session on a number of other reading and writing tests that will take approximately 35 minutes in total.

Your child's participation in this study is completely voluntary. Although it would be greatly appreciated if your child participates in the study, you should not feel obliged to have your child participate in this study; there are no consequences for not participating. Your child may also withdraw at any time with no effect on his/her standing in school. Your child has the right to inform the researcher that s/he does not wish to participate in the testing. You also have the right to email the researcher if you do not want your child to continue with the testing and this will end your child's participation. Should you decide to withdraw your child, you may request removal of all or part of your child's data. Your child will be tested in a quiet place in the school

during the months of September, October, and November 2014. I will ask your child's classroom teacher about your child's exact date of birth and if Arabic is your child's first language.

Your child's responses will be kept confidential. I will not use your child's name or any information that would allow the child to be identified. Only my supervisor and I will have access to this information. The results will be published in my doctoral thesis, and may also be published in professional journals or presented at scientific conferences. Any such publications or presentations will be of general findings and no individual child will be able to be identified in any publication. The data will be kept in a locked room, and that data files will be kept on password-protected computers. Data will be retained indefinitely, for later analysis. If data are used for secondary analysis they will contain no identifying information.

Although your child will not benefit directly from the study, I hope to learn more about how children read Arabic, and I hope that what is learned as a result of this study will help us to better understand Arabic reading and how to develop Arabic reading books and teaching materials based on sound research. If you wish to receive a summary of the findings, please provide your e-mail address on the Consent Letter; we will send you a copy of these findings when the study is complete.

Any questions about study participation may be directed to the research investigator, Sana Tibi at (s.tibi@queensu.ca) or to my supervisor, Dr. John Kirby at 613-533-6000, ext 77231 or (kirbyj@queensu.ca). Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at chair.GREB@queensu.ca or 613-533-6081.

Thank you.
Sincerely,
Sana Tibi

Consent Form

This consent form will be translated into Arabic

Project title: Cognitive and linguistic factors in learning to read Arabic among Grade 3 students



Please read the following, sign at the bottom, and return the form to your child's classroom teacher. Retain the second copy for your records.

- 1- I have read the Letter of Information and Consent form and have had any questions answered to my satisfaction.
- 2- I understand that my child will be participating in the study called Cognitive and linguistic factors in learning to read Arabic among Grade 3 students. The purpose of this study is to understand the factors that contribute to reading among Arabic-speaking children, in order to help us understand more fully reading development and its failures in the Arabic language. I understand that this means that my child will be asked to read some words, point to some pictures, and complete short sentences which all will be similar to what my child does in any Arabic language class. My child will be assessed individually in two 25-minute sessions and in a group in one 25-minute session and one 35-minute session.
- 3- I understand that my child's participation in this study is voluntary and my child may withdraw at any time with no effect on his or her standing in school. My child has the right to inform the researcher that s/he does not wish to participate in the testing. As a parent, I also have the right to email the researcher if I do not want my child to continue with the testing and this will end my child's participation. Should I decide to withdraw my child, I may request removal of all or part of my child's data. I understand that my

child will be tested in a quiet place in the school during the months of September, October, November, and December 2014. I also understand that you will be asking my child's classroom teacher about my child's exact date of birth and if Arabic is my child's first language.

4- I understand that my child's responses will be kept confidentially. You will not use my child's name or any information that would allow my child to be identified. Only the researcher (Sana Tibi) and her supervisor (Dr. John Kirby) will have access to the data. The results will be published in her doctoral thesis and may also be published in professional journals or presented at scientific conferences. Any such presentations will be of general findings and no individual child will be able to be identified.

5- If I wish to receive a summary of the findings, please provide your e-mail address below; we will send you a copy of these findings when the study is complete.

I am aware that if I have any questions, concerns, or complaints, I may contact Sana Tibi at s.tibi@queensu.ca or her supervisor, Dr. John Kirby at 613-533-6000, ext 77231 or at kirbyj@queensu.ca; or the Chair of the General Research Ethics Board at 613-533-6081 at Queen's University or chair.GREB@queensu.ca.

I have read the above statements and freely consent that my child participates in this research: Please sign one copy of this Consent Form and return to the teacher. Retain the second copy for your records.

Name of Child: _____

Name of Parent (please print clearly): _____

Signature: _____

Date: _____

To receive a summary of the findings, provide your e-mail address:

**Project title: Cognitive and linguistic factors in learning to
read Arabic among Grade 3 students**



Recruitment:

The following letter will be sent to the head of Research Ethics office at the Ministry of Education in Dubai, UAE who will send the letter with the principals of the participating schools.

To whom it may concern,

My name is Sana Tibi and I am a doctoral student in Cognitive Studies under the supervision of Dr. John Kirby from the Faculty of Education at Queen's University, Ontario, Canada. I am writing to seek the permission of the Ministry of Education to have access to public elementary schools, Grade 3 in particular, and be able to conduct my research. My research study is about assessing reading-related measures of Arabic-speaking children in order to help me understand more fully reading development and its failures in the Arabic language. The factors that affect Arabic reading have not been widely studied. The tasks will include a variety of measures to cover both the cognitive and linguistic constructs of reading in Arabic and will entail different dimensions (production, judgment, reading, and writing). Most of the tasks will require saying, reading, choosing and writing single words in addition to naming some pictured items and repeating some numbers. As for the Matrix Analogies nonverbal abilities test, children will be given clear instructions and examples to clarify the process of choosing the geometric shape from 3-4 choices to complete a specific geometric design. I will supply you with a copy of all testing materials if you wish.

In order to conduct the study, I need to assess 180 children (90 boys and 90 girls) on a number of reading measures. To carry out the assessment, I will need to meet with each child individually two times as well as test all children in groups on some other measures. Each child will be assessed individually in two 25-minute sessions and in a group in one 25-minute session and one 35-minute session. Individual tests will take place in a safe and quiet place recommended by the principal in the school. Group tests will take place in the children's classroom. No one will have access to these data except my supervisor and myself.

A letter of information explaining the purpose of the project and the procedure to take place along with a consent form will be provided to the parents prior to the beginning of the assessment procedures. Only parents who sign the consent forms will have their children participating in the study. In the letter of information as well as the consent form, contact details of the Graduate Research Ethics Board, my supervisor and myself will be provided. Parents will be able to contact any of these parties should they wish to inquire about specific information.

I will be glad to give a workshop on Arabic literacy to all elementary Arabic language teachers in each of the public schools to which you grant me access. If you have any questions about the study, please feel free to contact me at s.tibi@queensu.ca or my supervisor Dr. John Kirby at kirbyj.@queensu.ca or at (613-533-6000), ext. 77231.

Thank you very much for your consideration.

Sincerely,

Sana Tibi

Appendix B

Overview of Morphological Awareness (MA) tasks

#	Name of test	Example
1	Picture Choice	<i>Children are shown 4 pictures to choose one from representing the target word said by the experimenter. (e.g., bread, <u>baker</u>, beads, tailor).</i>
2	Sentence Selection	<i>Children are asked to select the morphologically appropriate word from a choice of four alternatives (e.g., I live in this/F, <u>this/M</u>, these two, these/pl) house.</i>
3	Sentence Completion	<i>Children are asked to complete each sentence with the correct form from the given word (root). (e.g., “to clean”. The teacher said: we have to keep the ____ of the school. The target response is “cleanliness” which is a derived noun from the given root.</i>
4	Morphological Relation Judgment	<i>The child needs to judge by saying Yes or No if pairs of words are related or not in meaning. (e.g., hunt and hunter (Yes); clap and cage (No).</i>
5 & 6	Word Analogy-administered in Standard and Local Arabic	<i>The child needs to produce a word to complete an analogy. (e.g., she student: plural female students (regular): he student: plural male students (irregular).</i>
7	Morphological Composition	<i>Children are presented in print with words followed by a + sign and a suffix and are asked to write the correct word with the inflection attached to it.</i>
8	Sentence analogy	<i>Children are provided in print with a pair of sentences (a:b) and then with a sentence (c) and the child is expected to produce/compose a sentence analogous to the given sentence and the pair. (e.g., Tom helps Mary: Tom helped Mary:: Tom sees Mary: _____).</i>
9	Word Analysis	<i>Children will be asked questions such as: Is there a little word in “danced” that means something like “danced”? Children will be given partial marks depending on how many morphemes they can decompose/extract. This test in Arabic will include what is known as one-word sentences (one word containing a verb, subject & object).</i>
10	Morphological Decomposition	<i>Children will be provided in writing with a suffixed word and a sentence that has a blank. The child is expected to complete the sentence with the correct form of the provided word. This is done by decomposing the target word. (the child is given the word “farmer” and asked to complete the sentence with the correct word by decomposing it: “The plowed fields are on the _____. (farm).</i>

Note. F= feminine, M = masculine, pl = plural

Appendix C

Arabic Study Measures

Reading Measures

Word reading.

#	Words	\sqrt{X}	Comments
1	في		
2	أنا		
3	كان		
4	هو		
5	الله		
6	الصف		
7	ماذا		
8	الكتاب		
9	الذي		
10	أقرأ		
11	الأطفال		
12	الأرض		
13	تحتها		
14	ذلك		
15	معلمي		
16	الملونة		
17	سيفعل		

18	الفتى		
19	الأسئلة		
20	المدينة		
21	بطاقة		
22	المفاهيم		
23	عُكُوبُوت		
24	الصحة		
25	رئيس		
26	يستخدم		
27	نهاية		
28	أتذكر		
29	أعجبتني		
30	مسرحية		
31	أزهارا		
32	عبارتين		
33	اختراع		
34	شاطئ		
35	الآخرين		
36	كثيرا		
37	يحفظها		
38	دائرة		
39	الرياضية		
40	إضاءة		
41	الجائعة		
42	تتبعث		
43	زملائي		

44	وظيفتها		
45	قررت		
46	خمسين		
47	المتسابقون		
48	التخصصي		
49	أتأمل		
50	مُسْتَطِيل		
51	المؤلفون		
52	رأسيتان		
53	حياتنا		
54	سريره		
55	عزيمتك		
56	ليعالج		
57	استفدت		
58	يناقش		
59	يحلها		
60	أُشْتَرَى		
61	استمعت		
62	القرويين		
63	مبصرا		
64	لاحظنا		
65	المستشفيات		
66	يتفاعل		
67	الرحالتان		
68	الإيماءات		
69	ينشدون		
70	المتفوقون		

71	شَلالات		
72	وَجوههم		
73	ضوء		
74	صائمين		
75	أضحى		
76	الخضراوات		
77	قارئ		
78	سيكررن		
79	ليبيعتها		
80	اصبروا		
81	مقترحاتكم		
82	ليستيقظ		
83	المسورة		
84	إقليمياً		
85	الدواوين		
86	ترنّموا		
87	فانتظروهم		

Note: All words appeared vowelized

Pseudoword reading.

Score _____

#	√/X	Comments		
1	ط		19	غَيْقَاءُ
2	ضُقُ		20	طَحَاضِمُ
3	فَا شْ		21	تَجَاعَشْ
4	ذِيصَ		22	ارْتَعَى
5	شَكْدُ		23	اَجْلُود
6	رَوْخُنْ		24	جَجَبَى
7	سُوَيْجُ		25	هَنْدَلَع
8	خُوَيْفُتْ		26	يَسْتَرْب
9	الصُّكَامِ		27	سَنَسْتَغِيرِج
10	أَرِيضَنَ		28	تَقَامَجَتْ
11	غَرِيفَاتْ		29	نُويْطَرُومَا
12	صُقَيْرَاوَانْ		30	فَرَنْتَنْظَحْنَا
13	الدَّمَارَاتِ			
14	جُبَيْهَلُوم			
15	مُؤُوسْ			
16	بَبِيرَامَا			
17	غَرِيحَةَ			
18	ثَامِحْ			

Note: All pseudowords appeared vowelized

Word-reading fluency.

قَالَ	أَنَّ	مِنْ
الصَّيْفُ	رَسُولُ	أَوْ
الَّتِي	كِتَابُ	لِمَاذَا
الْمَلِكُ	أَطْفَالُ	أَبَدًا
مُدْرِسِي	تِلْكَ	عَيْنُهَا
مَتَى	سَيَعْمَلُ	مُلَوَّنَةٌ
الْحِصَّةُ	جَدِيدَةٌ	الْأَمْثِلَةُ
أَمَانَةٌ	يَسْتَخْدِمُ	رَئِيسَةً
هَدِيَّةٌ	أَذْهَلْتَنِي	يَتَفَكَّرُ
التَّعْدِي	اللَّاعِبُونَ	خَمِيسُ
أَصْدِقَاؤُنَا	مُسْتَحِيلُ	أَتَأَلَّمُ
الذَّنْبُ	مَسْرُحُنَا	هَوَائِيًّا
اشْتَرَيْتُ	لِيُعَاتِبَ	مَشْكَلَتُكَ
اهْتَدَى	يُهْدِدُهَا	يُنَاشِدُ

قَصَصاً	خَادِمَتَيْنِ	اعْتَرَاظَ
خَرَانِطُ	الْآخِذِينَ	كَثِيراً
يَضَعُطُهَا	فَنَرَانِ	الْحِسَابِيَّةَ
إِسَاءَةً	الْمَائِلَةَ	تَنْهَمِرُ
كَهْرِبَانِي	مَرِيضَتُهَا	رَدَّدَتْ
اسْتَمْتَعْتُ	لُغَوِيَّينَ	مُهْمِلاً
لَا حَقَّنَا	الشَّخْصِيَّاتُ	يَنْتَابُ
الْفَتَاتَانِ	مَسَاءَهُمْ	يُنْصِتُونَ
يَتَسَابِقُونَ	شَلَالَاتُ	أَعْدَاؤُهُمْ
الْحُلُوى	شَيَيْنِينَ	اذْكُرُوا

Text-reading fluency.

هِنْدُ تُحِبُّ الرَّسْمَ كَثِيرًا ، وَ تَقْضِي وَقْتَ فَرَاغِهَا فِي رَسْمِ لُوحَاتٍ فَنِّيَّةٍ. قَرَرْتُ هِنْدُ أَنْ

تَشْتَرِكَ فِي مُسَابَقَةِ الرَّسْمِ لِلأَطْفَالِ ، فَكَّرْتُ طَوِيلًا فِي مَوْضُوعِ تَرْسُمِهِ لِلْمُسَابَقَةِ

اِقْتَرَحْتُ أُمُّ عَلِيَّهَا أَنْ تَرْسُمَ عَلَمَ دَوْلَةِ الإِمَارَاتِ الْعَرَبِيَّةِ الْمُتَّحِدَةِ أَعْجَبَتْ هِنْدُ الْفِكْرَةَ

فَجَلَسَتْ فِي عُرْفَتِهَا وَ بَدَأَتْ الرَّسْمَ ، وَ حِينَمَا أَرَادَتْ تَلْوِينَ الْعَلَمِ وَجَدَتْ أَنَّ اللَّوْنَ الْأَخْضَرَ فَارِغٌ

فَجَلَسَتْ أَمَامَ لَوْحَتِهَا حَانِئَةً ، وَ فَجْأَةً ظَهَرَ الْفَرْخُ عَلَى وَجْهِهَا ، إِذْ تَدَكَّرَتْ مَا كَانَتْ تَفْعَلُهُ مُدْرِسَةُ

الرَّسْمِ ، وَ سَرَّعَانَ مَا مَرَجَتْ هِنْدُ اللَّوْنَيْنِ الْأَزْرَقَ وَالْأَصْفَرَ ، فَظَهَرَ اللَّوْنُ الْأَخْضَرُ. نَادَتْ هِنْدُ

بِصَوْتٍ مُرْتَفِعٍ: أُمِّي ، أُمِّي وَجَدْتُ اللَّوْنَ الْأَخْضَرَ! لَوْنْتُ هِنْدُ اللَّوْحَةَ ، وَاشْتَرَكْتُ فِي

الْمُسَابَقَةِ وَكَانَتْ سَعِيدَةً كَمَا شَعَرْتُ أُمُّ هِنْدُ بِالْفَخْرِ بِابْنَتِهَا هِنْدُ .

Maze reading comprehension passages.

كان يا ما كان في قديم الزمان ولد اسمُه ناصر ، وكان يُحبُّ أن يذهبَ مع أبيه إلى الصَّيد. في عطلةٍ

نهاية الأسبوع ذهبَ ناصر مع أبيه إلى (البلح، البحر، الحبر) . فرح ناصر كثيراً لأنَّه سيصيدُ

(الأشواك ، الأسماك، الأشجار). استعدَّ ناصر للرحلة و جهَّزَ كُلَّ ما يلزمُ من ملابس البحر و (عبارة،

صنارة، قيثارة) الصَّيد. قال والدُ ناصر: يجبُ أن نذهبَ إلى السوق لـ (اشترينا، نشترى، نفترى) الطَّعمَ للأسماك.

في عطلة العيد أرادتُ الأسرة الذهابَ إلى مكانٍ جميلٍ. قال الأبُ هيّا نذهبُ إلى (الحبر، البحر،

المزرعة) للصَّيد والسَّباحة. قالتُ الأمُّ : لماذا لا نذهبُ إلى (الشاطئ ، المزرعة ، المطار) ليجتمع البلح

والخضار. قالتُ مريم: لماذا لا نذهب إلى السوق لأشترى (علبة، مدرسة، لعبة) جديدة؟ أمّا محمد

فأراد الذهابَ إلى القرية (العالمية، العالية، العلية) للعبِ والشراء في آنٍ واحدٍ! ضحك الجميع وقال

الأب أنت (ذكيّ، ذكيّة، زكيّ) يا محمد!

فَكَرَّ أَحْمَدُ بِصُنْعِ طَائِرَةٍ وَرَقِيَّةٍ فَأَحْضَرَ قِطْعَةً مِنَ (الحبر، الورق، الورقية) وَأَلْصَقَهَا عَلَى مَجْمُوعَةٍ

مِنْ (العيدان، الجيران، الحيوان) وَخَرَجَ مَسْرُوراً يَحْمِلُ طَائِرَتَهُ (لِيُطَيِّرَهَا، لِيَرْقُصَهَا، طَارَ)، لَكِنَّهُ لَمْ

يَتِمَكَّنَ مِنْ ذَلِكَ بِسَبَبِ عَدَمِ وَجُودِ الْزِّيَّاحِ. صَمَّمَ أَحْمَدُ أَنْ يَبْحَثَ عَنِ (الْخَلِّ، الْحَلِّ، الْهَالِ)، فَحَاوَلَ مَرَّةً

أُخْرَى وَقَرَّرَ أَنْ يَذْهَبَ إِلَى مَكَانٍ (أَحْلَى ، أَغْلَى، أَعْلَى) مِنَ الْمَكَانِ الْأَوَّلِ، صَعَدَ أَحْمَدُ هَذِهِ الْمَرَّةَ إِلَى

أَعْلَى (الْجَبَلِ، الْحَبْلِ، الْجَمَلِ)، وَلَكِنَّ الطَّائِرَةَ لَمْ تَطِرْ !! لَاحَظَ أَحْمَدُ أَنَّهُ نَسِيَ أَنْ يَصْنَعَ (الْفِيلَ ، الذَّيْلَ ،

النَّيْلَ) فَاسْرَعَ وَأَضَافَ ذَلِكَ وَطَارَتِ الطَّائِرَةُ أَخِيرًا. فَرِحَ أَحْمَدُ كَثِيرًا لِأَنَّ طَائِرَتَهُ طَارَتْ (عَمِيقًا،

غَالِيًا ، عَالِيًا).

سَاعَدَ أَحْمَدَ (بَعْدَ، عَضَ ، بَعْضَ) أَصْدِقَائِهِ بِعَمَلِ طَائِرَةٍ وَرَقِيَّةٍ وَتَذَكَّرَ أَنْ لَا (يُمْسِي، يَنْسَى ، تَنْسَى)

أَيَّ شَيْءٍ هَذِهِ الْمَرَّةَ وَكَانَ فَخُوراً بِنَجَاحِهِ فِي عَمَلِ (عَبْلَةٍ، عِلْبَةٍ، لَعْبَةٍ) الطَّائِرَةِ الْوَرَقِيَّةِ.

Phonological Awareness

Syllable deletion.

أَرْضُ مَنْ	أَرْضُنَا مَنْدِي	مُدْرَس عَادَ	مُدْرَسُون أَعَادَ
		شَاهِدَ	نَشَاهِدَ
		فَازَ	تَلْفَازَ
		خَاطِرَ	مَخَاطِرَ
		لَامَ	ظَلَامَ
		مَالَ	جَمَالَ
		دُودَ	مَسْدُودَ
		تَقْبَلَ	مُسْتَقْبَلَ
		عِيدَ	سَعِيدَ
		ذَكَرَ	تَذَكَّرَ
		قَصَ	مَقْصَ
		قَالَ	مَقَالَ
		طَارَ	قَطَارَ
		ضَارَ	خُضَارَ
		كَمَ	حَكَمَ
		عَادَ	سُعَادَ
		تَابَ	كِتَابَ
		جَدَّ	يَجِدَّ
		مَاءَ	سَمَاءَ
		زَارَعَ	مُزَارَعَ
		مَارَسَ	مُمَارَسَ

فَضَّلَها فَضَّلَها _____

يَرْمُونِها يَرْمُونِها _____

يُشْرِكُونَنَا يُشْرِكُونَنَا _____

مُتَحَدِّثٍ مُتَحَدِّثٍ _____

اشْتَرَكْتَ اشْتَرَكْتَ _____

سَلَامَتُكُمْ سَلَامَتُكُمْ _____

قَاوَمُوا قَاوَمُوا _____

الْجُودُ الْجُودُ _____

مُسَلِّمِينَ مُسَلِّمِينَ _____

الثَّمَارِ الثَّمَارِ _____

مَصْدَرٍ مَصْدَرٍ _____

طَالِبَاتٍ طَالِبَاتٍ _____

مُرْجَانَنَا مُرْجَانَنَا _____

هَزَّهَا هَزَّهَا _____

حَدِيقَتُكُمْ حَدِيقَتُكُمْ _____

مُسْتَشْفِيَاتُهُمْ مُسْتَشْفِيَاتُهُمْ _____

Phoneme deletion.

Trials:

صَدَّ صَدَّ
غَرَبِي غَرَبِي
كَتَبَتْ كَتَبَتْ

Final phoneme deletion.

قَرَأَتْ قَرَأَتْ _____

مَكْتُوبِي مَكْتُوبِي _____

عُشْبٍ عُشْبٍ _____

إله	إلى	_____
كانت	كانَ	_____
شمس	شم	_____
فقدت	فقد	_____
عمّة	عمّ	_____
الامّة	الامّ	_____
قَصَّرت	قَصَرَ	_____
حَبَل	حَب	_____
قَلَدَ	قَلَّ	_____
عندهم	عنده	_____
أسرار	أسرى	_____

Middle phoneme deletion.

شهر	شر
حار	حر
أزرق	أزق
مرضى	مضى
شرق	شق
دحرج	درج
ملاريا	ملايا
أكثر	أثر
مقصّف	مصف
يوم	يم
عود	عدّ

نای نئی
عین عن

Initial phoneme deletion.

آثار ثار _____
آدم دم _____
أصح صح _____
ينادي نادي _____
ألون لون _____

Blending.

قلم عُم ري رَسَم
أبي في هُو
صَاد يَ قول أَخ شاب
صَوْتاً قَدي م
شُي وخ ال ع ص ف و
حَ شَ رات تَ ك س ري مَ ل كَة
شُ ر ط ي ال م ن ز ل
ال م ساء ع د دَ أ ه د ا ن ي أ ع ش ا ش ه ا
ا س ت و ا ئ ي ز و ا ر ق ه م ا س ت د ر ج ه م

Orthographic Processing

Word chains.

Trials:

ل ع ب ج م ل
ن و ر ب ي ت ي د

د ر س ف ي

ب ع د م ل ك

أ ن ت ش ج ر م ع ه

ز ا ر ه د ي ة ع ي د

ب ا ع م ن س م ك ر ج ا ل

ل ا ي ن ق ل غ ي ر أ ح د أ م

أ ص د ق ا ع ن د ص غ ي ر س و ق ك ل ب

م ا ذ ا ب ع ي د م د ر س ة ذ ه ب ا ل ب ح ا ر

س ا ف ر ن ا ق ا ئ د ظ ب ي أ ش ر ب ج م ل

م ل ا ب س ح ت ي م ا ع ا ن ص ر ف ق ا ل ت ش م س

خ س ن ح ن ح س ا ب م س ج د ك ت ا ب أ ت م ر ل ع ب و ا

Orthographic choice.

Trials:

ناس
ضَاعَ
مدرسة
رَجُل

ناصر
ضَاعَ
مدرست
رِجُل

1	عَادَ	عَادَ
2	هُمَا	هُوما
3	سوق	صوق
4	مُشْتَهَدٌ	مُجْتَهَدٌ
5	ساحَة	ساحَت
6	مُعَلِّمي	مُعَلِّمي
7	بَعِيدِن	بَعِيدِ
8	صَقَطَ	سَقَطَ
9	أَشْمَشُ	الشَّمْسُ
10	طويل	طويلاً
11	ذِنْبَان	ذَابَان
12	درَسْتُ	دَرَسَة
13	ضفدع	ضفضع
14	دِرْهَمٍ	دِرْهَمِن
15	الأسبالة	الأسنلة
16	قِرَاءَة	قِرَاءَة
17	الْعِبُ	اللْعِبُ
18	شُبَّاك	شُبْبَاك
19	دَخَلُوا	دَخَلُوا
20	صَلَاتَهُ	صَلَاتَهُو
21	فَوْضَا	فَوْضَى
22	الْأَخَر	آخِر
23	ةَأَكُلُ	تَأْكُلُ
24	حَدِيقَتُنَا	حَدِيقَة نا
25	تَسْطِضِمُ	تَصْطِدِمُ

26	يُخْنِي	يُعْتِي
27	جَرِيدَة	جَرِيد
28	تَلْمِيذٌ	تَلْمِيز
29	تَقَالِيد	طَقَالِيد
30	مُسْتَشْفِي	مُسْتَشْفَى

Morphological Awareness

Root awareness.

Trials:

(نَظَرَ) (نَظَرْتُ، نَظَرْتُ، مَطَرُ، نَظَرُوا، يَنْظُرُ، انْتَظِرْ)
(لَعِبَ) (لَعَبْتُ، لَعَبْتُ، مَلَعَبُ، يَلْعَبُ، يَلْعَبُونَ، عَلَبَ)
(دَرَسَ) (يُدْرِسُ، مُدْرِسٌ، سَرَدَ، دَرَسَ، دُرُوسٌ، مَدْرَسَةٌ)

١- (رَجَعَ): (رَجَعْتُ ، رَجَعَ ، مَرَجَعُ ، رُجُوع ، عَرَجَ ، رَاجِع)

٢- (دَخَلَ): (دَخَلْتُ ، دَخَلَ ، خَلَدَ ، خَلَدَ)

٣- (رَفَعَهُ): (رَفَعْتُ ، رَفَعْتُ ، عَرَفُوا ، عَرَفُوا ، يَرْفَعُ)

٤- (مَسَكَ): (مَسَكَ ، مَسَكَ ، مَسَكَ ، مَسَكَ ، مَسَكَ ، مَسَكَ)

٥- (مَضَحَكَ): (مَضَحْتُ ، مَضَحْتُ ، مَضَحْتُ ، مَضَحْتُ ، مَضَحْتُ)

٦- (شَرِبَ): (شَرِبْتُ ، شَرِبْتُ ، شَرِبْتُ ، شَرِبْتُ ، شَرِبْتُ)

٧- (نَهَرَ): (نَهَرْتُ ، نَهَرْتُ ، نَهَرْتُ ، نَهَرْتُ ، نَهَرْتُ)

٨- (طَبَّ): (طَبَّبْتُ ، طَبَّبْتُ ، طَبَّبْتُ ، طَبَّبْتُ ، طَبَّبْتُ)

٩- (سَجَدَ): (سَجَدْتُ ، سَجَدْتُ ، سَجَدْتُ ، سَجَدْتُ ، سَجَدْتُ)

١٠- (تَوَقَّفَ): (تَوَقَّفْتُ ، تَوَقَّفْتُ ، تَوَقَّفْتُ ، تَوَقَّفْتُ ، تَوَقَّفْتُ)

١١- (مَخْبُوز): (مَخْبِر ، مَخْبَز ، خَزَز ، خُبَز ، يَخْبِز ، خَبَّاز)

١٢- (مُوَاطِنُونَ): (وَطَن ، طِين ، مَوْطِن ، مُوَاطِن ، طَنِين ، طَنَّ)

١٣- (كَبِير) : (كَبِيرَة ، كَبَر ، كَثِير ، أَكْبَر ، أَبْكَر ، كُبْرَى)

١٤- (خَادِم): (خَمَد ، اسْتَخْدَم ، خَاتِم ، حَاتِم ، خَدَم ، حَامِد)

١٥- (يَتَكَلَّم): (يَكْمَل ، مُتَكَلِّم ، كَلِمَات ، كَلَام ، كَلِمَة ، يَقْلَم)

١٦- (سِبَاحَة): (حِسَابَة ، تَسْبِيح ، سُبْحَان ، حِسَاب ، سَبَاح ، مَسْبَحَة)

١٧- (حِلْم): (حَمَل ، حَامِل ، حُلْم ، حَلَب ، يَحْلِب ، أَخْلَام)

١٨- (نَادَى): (يَنَادِي ، مُنَادِي ، نِدَاء ، نَادِي ، نَدَى ، مَنَادِي)

١٩- (أَجَرَ): (أَخَر ، آخِر ، مُسْتَأْجِر ، أَخِير ، أَحَر ، اجْتَر)

٢٠- (مُعَلِّمُونَ): (عَلَّمَ ، عَلَّمَ ، عَمِل ، مُعَلِّمَان ، عَامِل)

Standard word analogy.

Score: _____

- 1- ولد: أولاد:: بنت: بنات
- 2- حفيد: أحفاد:: حفيدة: حفيدات
- 3- صاد: يصيد:: عاد: يعود
- 4- طويل: طول:: عريض: عرض
- 5- قوة: قوي:: ضعف: ضعيف
- 6- دفاتر: دفتر:: أقلام: قلم
- 7- درّس: درّسوا:: لعب: لعبوا
- 8- برتقالة: برتقالتان:: موزة: موزتان
- 9- برج: أبراج:: مدرسة: مدارس
- 10- مكتبة: مكتبات:: فاكهة: فواكه
- 11- يحفظ: حفظ:: ينسخ: نسخ
- 12- يركب: راكب:: يعمل: عامل
- 13- ينشد: نشيد:: يهرب: هروب
- 14- يتأسف: متأسف:: يندش: مندش
- 15- رجل: رجال:: امرأة: نساء
- 16- اذهب: اذهبوا:: اذهبي: اذهبن
- 17- عامل: معاملة:: دافع: مدافعة
- 18- مخاطرة: يخاطر:: مراقبة: يراقب
- 19- جواب: إجابة:: امتحن: إمتحان
- 20- استقبل: استقبال:: انتظر: إنتظار

Local word analogy.

Score: _____

- 1- سيارة: سياير:: ريال: رياييل
- 2- عباية: عبي:: كندورة: كنادير
- 3- يرمس: ترمس:: يرقد: ترقد
- 4- أتسبح: يتسبح:: أقول: يقول
- 5- بشكاراة: بشكارتين:: فنيان: فنيانين
- 6- جوتي: جواتي:: دريشة: درايش
- 7- حريم: حرمة:: دريولية: دريول
- 8- مساند: مسند: زوالي: زولية
- 9- يعرس: معرس:: تعرس: عروس
- 10- أتغشمر: غشمره:: أكشخ: كشخة
- 11- يصيح: صياح:: يسولف: سوالف
- 12- يخم: مخمة:: يهف: مهفة
- 13- ربعة: ربيعات:: ربيع: ربيع
- 14- عيوز: عيايز:: موتر: مواتر
- 15- تتدخن: دخون:: تتحنى: حنا
- 16- عزم: عزيمة:: تريق: ريوق
- 17- خقاق: يتحقق:: كذاب: يكذب
- 18- يتريق: ريوق:: يخور: خوار
- 19- يتبخر: بخور:: يتعطر: عطور
- 20- يهذب: هذربه:: يشقح: شقحه

Morphological decomposition.

Score _____

- 1-حيوانات. الاسد ----- يعيش في الغابة
- 2- القريبات. هذه هي المكتبة -----.
- 3- محفور. العامل-----الارض.
- 4 - يبحثون. الرجل ----- عن الكنز.
- 5- بيتسمان. رأيت الطفل الذي -----.
- 6- الخرائط . تعلمنا كيف نرسم ----- دولة الامارات.
- 7- أضخم . الفيل حيوان -----.
- 8- الحطاب. جمع -----من الغابة.
- 9- أمطرت . ينزل ----- في فصل الشتاء.
- 10- الرياضيون. أحب حصة -----.
- 11- قصور. يوجد ----- الامارات في مدينة أبوظبي.
- 12- مطاعم. أكلت ----- الفطور في الصباح
- 13- رائدة . ركب ----- الفضاء المركبة.
- 14- الهوائية. لا يستطيع الانسان ان يعيش بدون -----.
- 15- حلويات. مذاق السكر-----.
- 16- مهرجون. تعجبني هذه ----- المضحكة.
- 17- تقرأن. ----- المعلم الدرس.
- 18- حجاج. ذهب جدي إلى مكة ل-----.
- 19 - معقول. خلق الله لنا -----لنفكر به.
- 20 - مسرحيات. أخذتنا أمي إلى نادي التراث لمشاهدة -----جديدة.

Sentence completion.

Score: _____

- 1- (أذن) . سَمِعْتُ صَوْتَ ----- .
- 2- (أهدى) . اشْتَرَيْتُ ----- جَمِيلَةً فِي عِيدِ الْأُمِّ .
- 3- (هو) . ----- يَرْكُضُونَ فِي السَّاحَةِ .
- 4- (لبس) . فِي الْعِيدِ نَرْتَدِي ----- جَدِيدَةً .
- 5- (نظيف) . قَالَتِ الْمُعَلِّمَةُ يَجِبُ أَنْ نَحَافِظَ عَلَى ----- الْفَصْلِ .
- 6- (سبَح) . إِنَّ أَخِي ----- مَاهِرٌ .
- 7- (ركب) . لَا أُحِبُّ ----- الدَّرَاجَاتِ .
- 8- (ورق) . أَعْرِفُ كَيْفَ أَصْنَعُ طَيَّارَةً ----- .
- 9- (فوز) . ----- الْمُنْتَصَابَةُ بِالْمِيدَالِيَةِ الْفِضِيَّةِ .
- 10- (كبير) . سَاحَةُ الْمَدْرَسَةِ ----- .
- 11- (مشي) . يُحِبُّ أَبِي أَنْ ----- كُلَّ يَوْمٍ .
- 12- (سفر) . نَحْنُ ----- فِي عَظَلَةِ الصَّيْفِ .
- 13- (الذي) . رَأَيْتُ الْوَلَدَانَ ----- فِي الْمَلْعَبِ .
- 14- (درهم) . مَعِيَ عَشْرٌ ----- .
- 15- (صديق) . عِنْدِي ثَلَاثَةٌ ----- .
- 16- (حرق) . يَسَاعِدُنَا رَجُلٌ الْإِطْفَاءِ فِي إِخْمَادِ ----- .
- 17- (سأل) . عِنْدَمَا لَا أَفْهَمُ شَيْءً ----- مُعَلِّمَتِي .
- 18- (غسل) . أَنَا ----- يَدَيَّ بَعْدَ الْأَكْلِ .
- 19- (حفل) . فِي كُلِّ عَامٍ ----- دَوْلَةُ الْإِمَارَاتِ بَعِيدِ الْإِتِّحَادِ .
- 20- (اجتمع) . حَضَرَ وَالِدِي ----- الْأَهَالِي فِي الْمَدْرَسَةِ .