

The Strategic Use of Morphological Information in Children Struggling with Reading Comprehension

by

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Abstract

This correlational study profiles morphosyntactic awareness in children struggling with reading comprehension in grades 5 to 7. The research is underpinned by two theoretical frameworks of reading and word identification. According to the Simple View of Reading, reading comprehension is the product of decoding and language comprehension. The Lexical Quality Hypothesis proposes that words stored in long term memory vary in the degree to which semantic, orthographic and phonological features are interlocked in long term memory.

Students completed measures of intelligence, reading and morphosyntactic awareness which were both oral and written to investigate a) the students' strategic use of morphemes in sentence-based tasks, b) whether difficulties with oral versus written tasks were more predictive of reading comprehension ability, and c) whether measures of morphosyntactic awareness could be differentiated on the basis of their usefulness in predicting comprehension ability.

Results showed that while word identification was the strongest predictor of reading comprehension, oral measures of morphosyntactic awareness were useful in a model of prediction. Results are examined in light of both theoretical frameworks. Difficulties for this sample of poor comprehenders likely originate in struggles with word identification. The finding that oral measures of morphosyntactic measures predict comprehension in for poor and typical comprehenders demonstrates the importance of considering sensitivity to morphologically complex words in oral language in late elementary school, a period of dramatic growth in knowledge of morphologically derived word forms.

- **Keywords:** morphological awareness; morphosyntax; reading comprehension; oral language; late elementary

Dedication

For Simon and Natalie

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Chapter 1. Introduction

"Why allyuh always downcouragin' a man so bai?"

-Kwame Weekes

The ability to understand, learn and read novel words in speech and print is predicated on a number of cognitive processes that have received a great deal of attention in recent decades. Research has found that the ability to recognize words and their components is a fundamental process upon which all other reading processes are grounded (e.g., Gough, Ehri & Treiman, 1992; Stanovich, 1991). Reading is purposive: we read to understand. Without the ability to accurately decode, recognize and see relationships between words, comprehension is limited and sometimes impossible.

English is a morphophonemic language; English words have units that are both sound-based (phonological) and meaning-based (morphological). For instance, the word *dotted* has two morphemes: the root *dot* and the suffix *-ed* which signals the grammatical past tense category. The *-ed* has three pronunciations depending on the root to which it is affixed (e.g., *dotted*, *jumped*, *stared*). Morphological information signals differences between spoken and written word forms. For example, *feeled* is an invalid word form while *field* is not; the *-ed* suffix is differentiated phonemically in the words *jumped*, *landed* and *banged* but not morphologically. Overwhelming evidence shows that phonemic awareness is critical for developing reading skill (Juel, 1988; National Reading Panel, 2000; Lyon, 1995; Adams, 1990) but that language processes beyond the phonological core contribute to variation in reading ability.

Investigations into links among morphology, word reading and reading comprehension are warranted for several reasons. First, it is logical that the variance in reading, writing and spelling skills in morphophonemic languages like English would be related to both phonological and morphological awareness. Second, morphemes are good indicators of the meanings of words. Approximately 60% of new words acquired by

school age children are morphologically complex (Nagy & Anderson, 1984). Thus, beyond sound-symbol correspondences, knowledge of morphemes and their patterns gives children a better chance of inferring the meanings of new words (Fowler & Liberman, 1995). Third, it is more economical to organize words in the orthographic lexicon by morphemes than by whole words (Elbro & Arnbak, 1996). Awareness of morphological structures means that words can be decoded and comprehended using units larger than phonemes, which in turn means that the demands on long term memory and working memory are reduced. Hierarchical regression analyses have shown that morphology makes a unique contribution to word reading beyond measures of intelligence, vocabulary and phonology (Deacon & Kirby, 2004; Singson, Mahony & Mann, 2000). Given the fact that the importance of phonology begins to shift to morphology around grade 4 (Carlisle, 2000), knowing how children develop morphological awareness is key.

According to the Simple View of Reading (Gough & Tunmer, 1986), reading skill is a product of word decoding and language comprehension. Perfetti (1985) and Pazzaglia, Cornoldi & Tressoldi (1993) showed that single-word decoding and comprehension processes are independent processes that rely on different cognitive abilities. Cain, Oakhill and colleagues (e.g., Cain & Oakhill, 1996; Cain & Oakhill, 1999; Yuill & Oakhill, 1991) showed that measures of linguistic ability and long-term memory predicted comprehension while skills in visual and auditory analysis were related to speed and accuracy of decoding but not to comprehension. In subsequent research, Oakhill, Cain & Bryant (2003) showed that while decoding and comprehension correlate highly, comprehension skill is differentiated by text integration skill, knowledge of story structure, metacognitive monitoring and working memory.

Language comprehension occurs at three levels: word, sentence and discourse. Phonological processing deficits have explained difficulties in single-word decoding but there is still the question of what accounts for difficulties in comprehension at the word level. For students with reading comprehension difficulties, the role of morphological sensitivity is unclear. Reading comprehension difficulties, by definition, are characterised by insensitivity to meaning structures in text. It has been estimated by researchers that 10 per cent of school-age children have good decoding skills but specific difficulties with

reading comprehension (Nation & Snowling, 1997). Since morphemes represent both meaning and orthography (at the word level) and their use is constrained by syntax, the question is whether students who struggle with comprehension have a sensitivity to or awareness of meaning at the word level insofar as they are able to recognize, use and spell morphologically complex words.

The concept of morphological awareness has been established using various tasks that fall broadly into three categories: word based, sentence based and priming.

Word-based tasks typically measure morphological awareness by having students manipulate, spell or use morphologically complex words in isolation. For instance, Kieffer and Lesaux (2007) showed typical and ELL students in grades 4 and 5 lists of roots and their derivations and tested the accuracy with which students could extract the root words from the morphologically complex words (decomposition). They found students with a stronger ability to extract root words from complex words (decomposition) (e.g., extract *run* from *runner*) had higher reading comprehension scores after controlling for reading fluency. They identified three factors that determined the difficulty of the decomposition task: a) whether there was a sound change (e.g., *popularity/popular*); b) whether there was a change in spelling (*swimmer - swim*); and, c) root word frequency. Words with spelling *and* sound changes were the most difficult (e.g., *strength - strong*).

Sentence-based tasks require students to complete a sentence using an appropriate word determined by adding the appropriate affix (e.g., The dog *burped/burping* after his lunch). Unlike word-based tasks, sentence-based tasks provide both semantic and syntactic context cues to facilitate the process of derivation or decomposition. For instance, Nagy, Berninger and Abbott (2006) measured morphological awareness on the basis of whether children could correctly identify the word that fit a sentence based on its inflectional or derivational suffix.

Priming tasks have been used to tease out ways that morphologically complex words are stored in long term memory (i.e., orthographically or semantically) using computer-based lexical decision paradigms. Participants are shown a prime word followed by a target word. They decide whether the target word is a real word by

pressing *yes* or *no* keys. Accuracy and response times are then calculated to measure which primes facilitate morphological processing. Psycholinguistic researchers widely agree that multi-morphemic words are decomposed into their constituent morphemes (Rastle & Davis, 2008; Frost, Grainger & Rastle, 2005) but there is little consensus in the field on how and when the recognition system decomposes printed stimuli.

Cognitive load in sentence-based tasks is twofold; students must derive or decompose morphologically complex words *and* ensure that new words grammatically fit the sentence. There is some evidence that students with reading comprehension difficulties struggle with syntactic awareness. For instance, Stothard and Hulme (1992) found that poor comprehenders performed poorly relative to typical comprehenders on the *Test for the Reception of Grammar* (Bishop, 1983). If it is the case that children with comprehension difficulties struggle with morphosyntax (i.e., the awareness of and ability to manipulate the rules that determine the relation between one linguistic form and another, defined by morphological and syntactic criteria), then we should expect that sentence-based tasks that depend on *both* morphological and syntactic sensitivity would vary with reading comprehension ability. Furthermore, since research has shown (Kieffer & Lesaux, 2007; Carlisle & Fleming, 2003) that word-based derivation and decomposition tasks vary in their level of difficulty based on whether words incorporate phonological shifts and spelling changes, it is plausible that reading comprehension ability may vary with word type.

This correlational study attempted to answer two questions. First, what is the morphosyntactic ability profile of students struggling with reading comprehension? Specifically, does performance on sentence-based morphological awareness (i.e., morphosyntactic awareness) tasks vary with reading comprehension ability? Second, is reading comprehension ability predicted by word type?

To answer these questions, a battery of IQ, literacy and morphosyntax measures were administered to children in grades 5, 6 and 7. The morphosyntax measures were oral and written and used real words and pseudowords. This allowed refining which types of that are most useful in predicting reading comprehension ability.

Results showed that the ability to derive and decompose words in speech combined with the ability to derive words in a written task were statistically measurable predictors of reading comprehension ability. After controlling for verbal IQ, morphosyntactic awareness accounted for a 28% improvement in predicting reading comprehension. In a subsequent analysis that controlled for verbal ability and word identification ability, morphosyntactic awareness contributed approximately a 6% gain over and above the variance explained by verbal IQ and word identification. Multiple regression analyses showed that a *verbal* test of morphosyntactic awareness in which students are required to derive and decompose morphologically complex words is a sufficient predictor of reading comprehension ability. This finding was corroborated by discriminant function analysis.

Decoding words that contain phonetic shifts (e.g., *music/musician*) were predictors of reading comprehension. In other words, cases where derived words bear the least resemblance to their roots are likely to be most problematic for students struggling with reading comprehension.

Discriminant function analysis (DFA) showed that the most parsimonious model in predicting membership in groups of low and average comprehenders included word identification, reading fluency, and the oral measures of derivation and decomposition. A student's ability to create a morphologically complex word given a root (derivation) and to extract the root from a morphologically complex word (decomposition) in oral language are likely the strongest morphological predictors of whether a student will have low or average reading comprehension ability.

For educators concerned with assessing and improving reading comprehension outcomes, this study provides evidence that low-level processes such as accurate word identification and adequate reading fluency are important considerations, even at the middle school level. When combined with oral measures of morphosyntactic awareness, tests of word identification and reading fluency are likely to be adequate for grouping children struggling with reading comprehension.

Chapter 2. Literature Review

The literature on word-level reading and comprehension processes is vast and is inclusive of both oral and written processes. It incorporates work on decoding, vocabulary processes, lexical and sublexical processing at multiple levels of linguistic categories (e.g., phonemes, syllables, morphemes, prosody, discourse) and cognitive categories (e.g., working memory, executive functions, visual and auditory processing).

Comprehension as a communicative objective is first addressed. The differences between oral and written language are highlighted and the ways these processes a) make different demands on the ways we understand language and; b) give pause to consider oral language development processes are important considerations for a study of reading comprehension. Word, sentence and discourse level processes are then discussed and the two theoretical paradigms in which the study is grounded are presented: Lexical Quality Hypothesis (Perfetti, 2007; Reichle & Perfetti, 2003) and the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990). Dual-route and connectionist models of word reading are discussed before turning to morphological processing, morphological awareness and their significance for word reading processes in typically developing children and those experiencing difficulty with comprehension.

2.1. What is Comprehension?

Comprehension is the ultimate aim of both speaking and reading. It is a complex, dynamic process that involves developing, specifying, and updating multiple mental representations or models latent in speech or text. Cognitive flexibility in comprehension processes (including word reading) in both children and adults has been emphasized by a number of researchers (e.g., Pressley & Afflerbach, 1995; Cartwright, 2002; Gleitman, 1985; Gaskins et al., 1988). Cognitive flexibility is a thinking disposition (Perkins, 1995), an epistemological position that information must be retrieved from a number of sources,

appraised for a variety of features and used differently according to the situation. Because acts of reading and comprehending are complex, involving multiple levels of mental representation such as the phonological, morphological, syntactic, semantic and pragmatic (Adams, 1990; Ehri, 1992; Perfetti, 1985; Just & Carpenter, 1980), cognitive flexibility is essential in shifting between text processing and comprehension strategies (Israel, 2008). Strong reading comprehension is a matter of thinking strategically.

There are important differences between spoken and written language (Cain & Oakhill, 2007). First, written language makes use of syntax and vocabulary that may not be used in everyday oral language experiences and thus would not be familiar to children. Take, for example, the following Grade 7 sample from British Columbia's Foundation Skills Assessment test:

Eva plods on over bumps and ridges where the cold has caught and frozen the waves once chased by the wind.

While the words may be decodable, they may not necessarily be familiar and, furthermore, the sentence requires both syntactic and prosodic skill to parse. For students who have not developed a strategic approach to comprehension, they often gloss over unfamiliar words or challenging sentences, producing a superficial understanding of the text (e.g., "*I think it was about waves or wind...?*").

A second factor of written language is that it is *decontextualized*. Written language does not describe events that are happening at the moment, as the individual is experiencing them. The cognitive demand to make accurate and appropriately updated mental representations of events in a text are higher since there is no present image or event against which the reader can "match" mental representations.

Written language demands attention to and integration of information across extended tracts of discourse. A listener can stop a speaker, ask for a repeat of the message, check for clarification and repeat pieces of conversation that they may have missed or misunderstood (and likewise, a speaker can inquire as to whether they are being understood by responding to quizzical looks). A reader cannot stop and interrogate the text with an explicit answer as an outcome.

Derivational morphology varies between oral and written language. One reason that derivational suffixes might be acquired later is because they are more frequent in written text and formal speech rather than in everyday conversation (Chafe & Danielewicz, 1987; Nagy, Diakidoy & Anderson, 1993). Accounting for ways morphologically complex words are used in speech and print may be important in understanding differences in morphological awareness in spoken and written language.

Thus, text is not simply speech written down. Comprehending text relies upon cognitive subskills that may not be involved in comprehending spoken language. Nonetheless, reading comprehension is a language-based skill, so an important question for researchers is the nature of the intersection between oral and written language skills.

Poor comprehenders experience difficulty in both listening and reading comprehension (Nation & Snowling, 1997). For instance, Nation, Clarke, Marshall and Durand (2004) conducted a comprehensive assessment of spoken language skills of poor comprehenders. These children struggled in a number of domains including vocabulary knowledge, morphosyntax (i.e., past tense inflection and sentence comprehension) and understanding figurative language. However, poor comprehenders performed well on tasks tapping phonological awareness and processing which strongly predict decoding and word reading ability. Reading comprehension is not merely a by-product of accurate, fluent decoding. Struggling readers may have difficulties that are (a) not tied to decoding ability and (b) specific to features and constraints of textual language.

2.2. The Simple View of Reading

According to the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), skilled reading is the product of decoding and language comprehension. Good readers must be accurate and fluent in decoding words in print and they must understand the meaning represented by words, sentences, paragraphs and discourse. Decoding and comprehension processes are reasonably independent - each skill relies on different underlying cognitive and linguistic skills. For instance, deJong and van der

Leij's (2002) longitudinal study explored the growth of word development and reading comprehension among children in grades 1 and 3. Phonological skills strongly predicted decoding while reading comprehension correlated with word decoding speed, vocabulary and listening comprehension. Muter, Hulme, Snowling and Stevenson (2004) also found that word recognition skills were predicted by phonemic sensitivity and letter knowledge while comprehension was predicted by word recognition skills, vocabulary knowledge and grammatical skills. The corpus of research on cognitive processes underlying the acquisition of word reading is large (e.g., Goswami & Bryant, 1990; Rack, Hulme & Snowling, 1993; Shankweiler et al., 1999) and a considerable body of research shows that children who have word reading deficits will have reading comprehension deficits (Shankweiler, 1999; Torgesen, 2000). Without skill in sounding out words accurately or reading with sufficient fluency, students are unable to glean meaning from text.

The contrasting group are poor comprehenders who experience difficulty in understanding text despite being able to decode accurately and fluently (Cain & Oakhill, 2007). Skills underlying reading comprehension such as oral language ability, self-regulation, the ability to make inferences, skill in understanding figurative language and grammatical awareness have been investigated less extensively.

2.3. Oral Language and Reading

To understand written language, an individual must understand that language in spoken form. Language develops as individuals interact with the world. Thus, there is variation in development according to the history and social environment in which communication is embedded. Although language is experienced as a unitary whole, in another sense it is an "invisible, internal, multicomponent system with subsystems that mediate interactions between the internal mental world, where thinking occurs..." (Berninger & Abbott, 2010, p. 649). Skilled reading comprehension involves accurate and fluent decoding of text and it is widely accepted that oral language skills underpin successful reading comprehension (Clarke et al., 2010; Muter et al., 2004; Nation et al., 2010). The role of oral language has a number of implications for word reading, vocabulary and comprehension. Research on the relationship between listening

comprehension and reading comprehension has shown low correlation between reading and listening comprehension in beginning readers who are still learning to decode words. However, this correlation steadily increases and asymptotes by the time students reach high school when decoding differences among readers are quite small (Sticht & James, 1984). As well, research shows not only that early language experiences are critical in building vocabulary and grammatical awareness, but that the correlation between oral language and reading comprehension increases as efficiency of decoding skills improves (Siegler, 1997).

Socioeconomic status (SES) has been implicated as an important predictor of oral language skills which in turn impact success in literacy in school-aged children. For instance, Hart and Risley (1995) found a SES a strong predictor of the quantity of words as well as the quality of language to which the children were exposed. Children in low SES families were exposed to short imperatives and typically negative words such as "No. Stop it." Conversely, children from high SES families tended to be exposed to both a greater quantity and quality of words. These children's language experience included descriptive language, expansive narrations and reward for communication (e.g., "Use your words. Good job!"). Children with a paucity of oral language experiences or oral language impairment are nearly five times as likely to experience difficulty with reading (Catts et al., 2001). Spira, Bracken & Fischel (2005) found differences in oral language skills in grade four were strongly related to linguistic attributes measured in kindergarten. In a sample of children showing poor decoding skills in grade 1, children who made greater gains in reading by grade 4 were those with stronger oral language skills. The researchers surmised that oral language skills help children compensate for weak decoding skills on the basis of context. This accords with Stanovich (1980, 1984) and Shaywitz et al. (2003) who likewise argue that particular domains of strength in reading can compensate for weaker ones. A study by Kim, Petscher, Schatschneider & Foorman (2010) on growth rates in oral reading fluency showed that both the initial status *and* growth rate in oral reading fluency was dominant over phonological awareness, phonological decoding fluency and letter naming fluency in accounting for the acquisition of reading comprehension skill. Furthermore, a grade 1 student's ability to read aloud provided the most information about reading for that grade and for performance later, in grade 3.

Studies involving school-age children who experience both oral language and print have shown that poor comprehenders struggle to comprehend spoken texts (e.g., Cain, Oakhill & Bryant, 2000a; Stothard & Hulme, 1992). Cain and colleagues (Cain, 2003; Cain & Oakhill, 1996) found that students struggling with reading comprehension also have difficulty producing coherent narratives.

A recent study by Poll and Miller (2013) on weak language and reading abilities in 8-year-olds traced vocabulary knowledge and word combining skill at age 2. Results from a logistic regression analysis showed that children who did not combine words at age 2 were at significantly higher risk of having poor reading comprehension skill at age 8 as compared to peers who were typical in their skill to combine words. Combining words is one of the first skills small children acquire in manipulating the morphological aspect of language. So, examining evidence of early difficulties in the morphological domain may be a productive area for investigation.

2.4. Levels of Comprehension

Text comprehension occurs at three different levels: word, sentence and discourse. There is evidence to suggest that different comprehension subskills and difficulties are associated with each level.

2.4.1. Word Level

At the word level, individuals access and coordinate the meanings of individual words based on the simultaneous attention to orthographic, phonological and semantic cues and as research increasingly shows, morphological features. Mappings between form and meaning in words are rarely one-to-one. For instance, polysemy means that the same word can have different meanings (e.g., *I put the tire on the car vs. I hope to tire out my son before bedtime*) and the same morpheme can have different pronunciations (e.g., *walked, patted, landed*) or those pronunciations can change with the addition of a morpheme (e.g., *nation/national*). Word meanings change with syntactic context (e.g., *It was a good party vs. It was good to party*) and as Nagy (1997) points out, almost every word has a new shade of meaning within every context. The word level

concerns the readiness with which students decode words and represent and access word forms in long term memory with the aim of summoning meaning with enough speed, accuracy and flexibility to support higher-level discourse processes.

Lexical Quality Hypothesis

The Lexical Quality Hypothesis (LQH) (Perfetti, 2007; Reichle & Perfetti, 2003) explains the link between poor word reading and poor comprehension. According to the LQH, mental representations of word forms vary with regard to their *lexical quality* which is defined as the degree to which orthographic, phonological and semantic features are well represented and "well interlocked" (p. 231) in long term memory. Lexical quality (LQ) is a network of components that underlies efficient reading processes including knowledge of word forms (grammatical awareness, spellings and pronunciations) as well as meanings (Perfetti, 2007). It refers to the extent to which a reader holds a representation of a word form that is reflective of the word's actual form and semantic features. For instance, LQ accounts for the means by which we differentiate between two pronunciations and meanings of *content* (i.e., *a feeling of goodness* or *that which is contained in a box or book*). In a morphological sense, LQ helps us differentiate between the literal and figurative meanings of *skinny* (i.e., *thin* or *characterized by lots of skin*).

There are four main representational features of word identity implicated in reading processes: orthography, phonology, morphosyntax and meaning; as well as a fifth called *constituent binding*. Constituent binding is the degree to which each of those four features are connected together and cohere; it characterizes how well one element is specified relative to the others. Thus, each individual holds a vocabulary that has words and word forms widely varying in LQ. Poor word readers are likely to have a disproportionate number of lexical representations that are underspecified and loosely bound.

Central to the hypothesis of lexical quality is an individual's experience with both oral and written language. The more words an individual knows, the more likely that individual can infer the meanings of unfamiliar words (Nelson, 1996). Perfetti (2007) is careful to point out that the variability in LQ is not just oriented towards the size of a reader's vocabulary but involves the *stability of knowledge* around a word's form and

meaning. High lexical quality occurs in cases where components are highly specified and tightly bound. A higher degree of LQ translates to a higher readiness of processing and in turn, greater ease in retrieval of spelling, meaning and pronunciation as well as cognitive flexibility and precision in teasing out form-meaning complexities.

For children learning to read, these components are more loosely bound as they are still developing an accurate representational framework. Perfetti and Hart (2002) conducted a factor analysis for a series of tasks designed to tap lexical quality (LQ) for less-skilled adult readers and found that orthographic, phonological and meaning formed three separate dimensions. Thus, it would be possible that young children learning to read might have stronger, more flexible phonological representations than meaning representations for many words. The authors argue that the components of lexical quality in children are still under development. Underspecified ties between the components of lexical quality may result in poor lexical quality. If there is individual variation in the profile of lexical quality components, then which components are supportive of and predictive of reading comprehension ability? For instance, Richter, Isberner, Naumann and Neeb (2013) used measures of phonological, orthographic and meaning representations rather than a more general measure of decoding to investigate this question. They found grade level differences could be accounted for entirely by individual differences in lexical quality. Accuracy and speed of access for all three types of representation accounted for 60% of variance in reading comprehension ability.

Reading Fluency

Poor reading fluency has been implicated as a cause of difficulties with reading comprehension. Reading fluency is theorized to be comprised of three components. *Accuracy* is the ability to correctly identify a word in isolation or in text. *Automaticity* is the immediate recognition of words that bypass decoding process (Wise et al., 2010). *Prosody* is the ability to provide the correct inflection and expression implied by the text (e.g., reading "I hate you!" in an angry voice or "Jeanette, can you please get your shoes on now?" with the appropriate tone for question-asking).

A number of studies have shown that reduced fluency impedes reading comprehension even when students decode accurately (Perfetti & Hogaboam, 1975;

Perfetti, Maron & Foltz, 1996) and improvements in fluency have been shown to be associated with improvements in comprehension (e.g., Berninger, Abbott, Vermeulen & Fulton, 2006; Cates, Thomason, Havey & McCormick, 2006). Automaticity of word identification, both in contextualized and decontextualized tasks, is the largest contributor to reading comprehension (Kuhn & Stahl, 2003), likely because swift and automatic recognition of words means that attentional resources can be allocated to text comprehension rather than decoding. Fluency difficulties become critical for students in later elementary grades who are making the transition from "learning to read" to "reading to learn" and moving from decoding individual words to automatic word identification.

Wise et al. (2010) conducted a study with grade 2 students and found that real-word oral reading fluency was the strongest predictor of reading comprehension over non-word reading fluency and oral reading fluency of connected text. In their review of the literature on reading fluency and reading comprehension, Paris, Carpenter, Paris and Hamilton (2005) concluded that low word-reading fluency is positively correlated with low levels of reading comprehension but advise it is incorrect to conclude that strong word reading skills are sufficient to ensure strong reading comprehension. Strong word identification and word reading fluency are necessary but not sufficient for text comprehension.

2.4.2. Sentence Level

At the sentence level, comprehension processes concern the coordination of semantic and syntactic knowledge as individuals must understand not only individual words, but how the nuances of word meanings are influenced by context. To use a prior example, a student might define *jumper* as *a person who jumps* in a measure of decontextualized word meaning. However, if the student were to read, *He slipped the jumper over his head*, the word *jumper* takes on a different meaning, according to the additional semantic and syntactic cues in the sentence (i.e., people who jump generally do not get slipped over the head).

Relatively little research has been conducted on sentence-level processes. Some studies show that children with text comprehension difficulties have deficits in syntactic

knowledge while other studies have shown little support for this type of deficit. For instance, Oakhill, Cain and Bryant (2004) found that syntactic ability was not predictive of reading comprehension for children aged 7 and 8 but it did predict comprehension one year later. Yuill, Oakhill and Parkin (1989) found that good comprehenders are better at resolving inconsistencies in sentences and paragraphs than poor comprehenders and the difference between the groups was more dramatic when the degree of textual inconsistency was increased.

Cain and Oakhill (2007) distinguish between syntactic knowledge (implicit knowledge of grammatical constructs while listening to sentences) and syntactic awareness (explicit or metacognitive aspects of grammatical knowledge that permits the individual to detect or correct errors). They found that the correlations between syntactic awareness and reading comprehension were more consistent.

2.4.3. Discourse Level

After accounting for the role of reading accuracy, fluency, oral language ability in reading and understanding words and sentences, there are higher level cognitive processes that play a role in reading comprehension. Skilled readers develop a representation of the overall structure of the text, use background knowledge to contextualize the material, develop a sense of story structure (e.g., narrative versus expository) and form understandings of the text based on information that may not necessarily be stated. Research on discourse level processes has shown that poor comprehenders struggle in a number of specific ways.

Working memory has been implicated in struggles to comprehend when reading. Working memory is an information-processing architecture that contains specific systems that encode, process, and maintain information (i.e., the phonological loop and visuospatial sketchpad) and which are governed by a central executive (Baddeley & Hitch, 1974). Where short term memory capacity refers to the temporary storage of information, working memory is the locus for *both* storing and processing information (Baddeley, 1986). Reading and comprehension are complex processes which draw on a large number of cognitive resources at the word, sentence and discourse level. To

reiterate, reading comprehension is an online process in which mental representations are continuously being acquired, updated and revised. Since reading comprehension is resource-heavy in terms of both information storage and processing, working memory has been investigated for its contribution to reading comprehension skill. In comparing typical and poor comprehenders, Cain, Oakhill and Lemmon (2004) found that the two groups were comparable on measures of short term memory but that poor comprehenders struggled on measures of working memory. Engle, Carullo and Collins (1991) found a strong correlation between working memory span and comprehension in children aged 7, 9 and 12. Converging evidence (e.g., Yuill, Oakhill & Parkin, 1989; Nation et al., 1999; Stothard & Hulme, 1995) shows that poor comprehenders show the highest impairment on tests of memory that require students to simultaneously store and process both digits and words/sentences. Memory impairments can arise from a number of sources such as inefficient word-reading, phonological processing deficits or poor semantic or syntactic skills but as Cain, Oakhill & Bryant (2004) found, working memory has a more direct relationship to reading comprehension over and above short term memory, word identification ability and vocabulary knowledge. Seigneuric and Ehrlich (2005) conducted a longitudinal investigation of the contribution of working memory capacity, vocabulary knowledge and decoding skill. Their results corroborated previous research. Decoding skills were important in the first years of reading acquisition, but as children matured, the relative contributions of vocabulary and working memory increased. In grade 3, the strongest predictor of reading comprehension ability was working memory capacity.

There is increasing evidence that children struggling with reading comprehension also have difficulties making inferences and integrating text. Neither speakers nor writers are explicit about every detail of a message. Readers and listeners must fill in details for conceptual coherence, interest, subtlety and humour. Readers must make inferences to fill in links between parts of the text using textual clues and prior knowledge. Poor comprehenders seem to be able to recall literal detail from texts (Oakhill, 1982) but they are less likely to use general knowledge combined with textual information to make inferences (Oakhill, 1984). Even when general knowledge was controlled, poor comprehenders generated fewer inferences as compared with students with typical comprehension ability (Cain, Oakhill, Barnes & Bryant, 2001).

When reading texts, we are sometimes called upon to infer the meanings of single novel words. *Instantiation* is a particular type of inference where the reader infers the meaning of a particular noun given the context of a sentence (Cain & Oakhill, 2007). For example, instantiation occurs when a reader infers that *fish* is likely a shark when reading "the fish frightened the swimmer". In an early study, Oakhill (1983) found that poor comprehenders made fewer instantiations than good comprehenders, likely because they fail to use sentence context to make sense of the novel word.

Metacognition, self-regulation and monitoring refer to processes of reflecting upon and troubleshooting one's comprehension processes. Anaphors are cohesive devices like *she* or *them* that maintain cohesion between sentences. For instance, in the sentence, "Sally threw the ball to Jack and then ran back to her house", the anaphor *her* refers to Sally. Anaphor resolution has been used to study comprehension monitoring because it highlights whether student integrate information across sentences and demonstrates whether students are attending to syntactic inconsistencies. Research on anaphor has shown that students who struggle with comprehension have weaknesses in comprehension monitoring (Ehrlich, 1996; Ehrlich, & Remond, 1997; Oakhill & Yuill, 1986) and that good comprehenders spend more time reading sections of text that contain semantic or syntactic inconsistencies (Ehrlich, Remond & Tardieu, 1999). Poor comprehenders have this difficulty in both spoken and written language (Megherbi & Ehrlich, 2005).

Metalinguistic ability has been recognized as a strong predictor of reading acquisition (Gombert, 1992; Nagy, 2007). Carlisle (2003) pointed out that Anglin's (1993) work highlights that engagement in morphological problem solving requires an awareness of the benefits of using morphology as a decoding strategy in the first place. Bowey and Patel (1988) stressed that in reporting the relationship between morphological awareness and reading, researchers must take into account a pre-existing general analytical disposition towards word structure and use.

Thus, to understand the scope of reading comprehension difficulties in a broader sense, it is important to consider ways that children struggle at word, sentence and

discourse levels. The study of morphological awareness in reading comprehension focuses on word and sentence-level processes to which we now turn.

2.5. Dual Route and Connectionist Models of Word Learning

Reading researchers use information processing models to understand ways that individuals transform speech and print and construct meaning from text. Perhaps the most important aspect of reading is visual word recognition; the ability to read starts with decoding words.

The task most frequently used by cognitive psychologists interested in reading is lexical decision. Lexical decision is an experimental paradigm in which participants decide whether a string of printed letters is a real word or a non-word. Experienced readers are likely to be familiar with approximately 20,000 words in print. Lexical decision is the means by which it can be ascertained whether individuals are discriminating words from non-words according to semantic, phonological, orthographic and in more recent research, morphological characteristics. Lexical decision tasks reveal how individuals recognize words as real or non-words without scanning through all 20,000 words (which would require a check of each word occurring at a rate of .03 milliseconds!) (Coltheart, 2006). If individuals do not scan through each and every lexical entry in lexical decision tasks (or in real reading tasks where they may stumble upon orthographically confusing names, spellings of unfamiliar words or words from different languages), how do we recognize, store and recall words? Given that decoding printed words relies upon knowledge of orthography, pronunciation and meaning, how does the processing of visual word forms proceed and on what basis are words organized in the (developing) lexicon?

There are two theoretical frameworks that describe the process of visual word recognition: dual-route models and connectionist models. The dual-route model is a model of reading based on the study of reading aloud behavior (Coltheart, 1978; Morton & Patterson, 1980; Paap & Noel, 1991). It has been the dominant framework in understanding reading behavior. It is so-named because it posits that there are two

routes from print to speech, based on three types of lexicon. The *orthographic lexicon* represents knowledge of word spellings. The *phonological lexicon* represents sounds or pronunciation of words. The *semantic lexicon* represents word meanings. The orthographic and semantic lexicons comprise the direct route from print to speech. The slower, indirect route involves phonological mediation - letters are translated into sounds in sequential fashion which permits recognition of word identities and access to word meanings (Barron, 1986). In his review, Coltheart (2006) gives the example of learning Russian names to illustrate the point. When adept non-Russian readers have to read and remember a name such as *Grigory Vassilyevich* or *Marta Ignatyevna*, they will generate a pronunciation and store it in memory. When a new name pops up later in the books, the reader will again use the indirect route to pronounce the name and gauge whether there is a match for the previously stored pronunciation. Since the capacity of visual memory is far less than phonological memory, we have a far better chance of remembering a name if it has been phonologically coded. *Non-lexical procedures* (i.e., phonological and semantic) are ways of locating a word in long term memory that has not been stored in printed form. The model assumes that in an alphabetic writing system, knowledge of word forms is based on regularities in phoneme-grapheme correspondences (Coltheart, 1978, 1987). Regular words like *pony*, *cake* or *submarine* could be processed either directly or indirectly but exception words such as *colonel* were processed as whole forms through the direct (orthographic, semantic) route. Non-words like *floop*, *spraft* and *furgibble* were processed by the indirect (phonological or lexical) route only since the only means of reading these words is by decoding left to right, letter string by letter string (Bjallid et al., 1997 for review). The fact that individuals can read real words, exception words and nonwords suggests that they have learned a set of rules around phoneme-grapheme correspondences, a position that was corroborated by Berko's (1958) productive morphology tasks in children. These tasks demonstrated that not only did individuals possess rule-based mental representations of phoneme-grapheme correspondences and morphological representations, but that these rules could be generalized to novel word forms

Connectionist models of reading (e.g., Plaut et al., 1996; Seidenberg & McLelland, 1989) arise from the use of computational models to recognize letter strings and compute meanings. Connectionists believe that the complexity of systems forms

from the aggregate behavior of large networks of processing units (Rumelhart, McClelland & Hinton, 1986). Units within the system are linked to form networks or pools. Computational models use the patterns of spreading activation between pools and the weights of those connections to determine the structure of the lexicon. Connectionist models have challenged the rule-based conception of word learning by showing that learning to recognize words and learning to read can be thought of as a process of algorithmically adjusting the weights between connections within a language system (Seidenberg, 2007). Where the dual-route models assume representation of word forms to be local (each word corresponds to a single unit in the lexicon) and processing is serial, connectionist models assume that words have a distributed representation and processing. A single, parallel distributed processing system is capable of encoding real words, exception words and nonwords using error-minimizing learning algorithms (Seidenberg et al., 1994). That is, words can be represented by the activation of numerous units in the system and likewise, any unit in the system has a role in representing many different words.

2.6. Morphemes and Morphology

Morphology is the study of forms. In the domain of linguistics, morphology is "... the study of the hierarchical and relational aspects of words and the operation on lexical items according to word formation rules to produce other lexical items" (Leong & Parkinson, 1995, p. 237). The study of morphology is concerned with word formation, including the ways new words are coined (e.g., *Brangelina*, *doable*) and the way words vary depending on their use in sentences (Lieber, 2010).

Morphemes can be free or bound. *Free morphemes* are those words that stand alone (e.g., *tree*, *cat*, *staple*). *Bound morphemes* must be connected to other words in order to have meaning e.g., *psych-* (*psychosis*), *re-* (*replay*), *-tion* (*observation*). The *root* of the word is the core of a word to which other morphemes are attached.

There are three types of bound morpheme or *affix*. *Prefixes* occur before the root, *suffixes* occur after the root and in some languages, *infixes* occur in the middle of the word (there are no infixes in English). Across languages, bound morphemes are

combined in a rule-based manner with regard to type of affix that can be added to particular word classes as well as the order in which these affixes can be added (Carlisle, 2003). For instance, English permits the word *gratifying* (*gratify* + *ing*) but the reverse is not permitted (*ing* + *gratify*). The class of bound morphemes is further subdivided into inflectional, derivational and compound morphemes. Inflectional morphemes constitute the grammatical content of words. They are constituted by affixes that reflect concepts of time, number and space. Derivational and compound morphemes, conversely, alter the meaning of the base word to the extent that the word class changes (e.g., *-less* can be added to word to mean *without*). Where inflectional morphemes constitute the grammatical aspect of language, derivational/compound morphemes constitute at least part of the lexical level of language. Researchers in cognitive linguistics make the critical distinction between these two systems (e.g., Talmy, 2001; Evans & Green, 2006), namely that each comprise a different type of linguistic system. The grammatical subsystem is a closed-class, notoriously stable system because it is difficult for a language to add new members. The grammatical systems in languages place a significant constraint on the types and forms of new words and expressions that may be introduced into a language. Consider the following example:

The dog **chased** the cat.

The **dogs** **chased** the **cats**.

Which dog **was** **chasing** the cat?

The words in bold type show changes to the grammar of the sentence and reflect the fact that the bound morphemes (*-ed*, *-s*) and the grammatical morpheme *which* produce a different interpretation of the *same* event, namely, the chasing of some number of cats by some number of dogs over some time sequence. Conversely, derivational/compound morphemes or the lexical subsystem is referred to as *open-class* since it is much easier to add members to this class. Using the same example, I can change the lexical content of the previous phrases, keeping the verb *chased* constant:

The **girl** chased the **boy**.

The **fireman** chased the **Dalmatian**.

The **beer** chased the **whisky**.

The sentences all have the same grammatical structure but the sentences no longer describe the same event. Where the closed-class grammatical system determines the structure, the open-class determines the content. Each event described is completely different because each lexical item prompts for richer concepts than those prompted for by grammatical elements (Evans & Green, 2006). The last sentence is peculiar for the additional reason that it is figurative, referring to a metaphorical drinking event in which a shot of whisky is followed by a quick gulp of beer rather than a literal high-speed pursuit. Thus, where the open-class lexical subsystem offers rich, nuanced variety of a large class of objects and events, the closed-class grammatical subsystem is responsible for schematic structures such as time, space, figure-ground relationships (e.g., The bike leaned against the wall) and force dynamics (e.g., The ball rolled towards the dog despite the stiff grass.).

The common example of the word *email* illustrates the point. With the advent of electronic mail, computer users sought shorthand for the term as it started to proliferate in everyday work. *Electronic* became abbreviated with *e* and was then compounded with *mail* to create the new lexical item, *email*. The word was not composed as *Maile* because *e* standing for *electronic* is a descriptive adjective that, according to English grammar comes before the noun to which it refers. In contrast, French grammar would permit *Maile* since its grammar dictates that adjectives follow nouns. Thus, while there is enormous variation possible on the lexical level, the terms must still be placed in a particular order according to grammatical rules so the word is understandable.

There are several characteristics in derivational morphology. First, it is systematic: There are regularities in form and meaning across related words. Second, derivational morphology is productive: It allows us to combine morphemes in both form and meaning to create novel words. Third, derivational morphology is constrained: While morphemes can be combined in novel ways to produce novel word forms (e.g., *lip-smackingly good*, *upsell*, *doable*) there are some forms that are not legal (e.g., *unsoapfulness*, *repuddingly*). Finally, it is quasi-regular (Seidenberg & Gonnerman,

2000), meaning that there are regularities (e.g., *baker*, *smoker*, *picker*) in how words are structured but there are deviations to greater and lesser degrees (e.g., *jumper* is both someone who jumps and in the United Kingdom, a sweater. On that note, a *sweater* is both someone who sweats and an article of clothing, although using *sweater* as a strict ontological category might be considered impolite.).

Furthermore, there are two types of derivations: Class 1 morphemes trigger changes to the base and/ or changes to stress assignment (e.g. – *ity* in *sanity*) while class 2 morphemes, which are *phonologically neutral*, do not (e.g. – *ness* in *promptness*) (O’Grady & Cuzman, 1997).

Two concepts are important to consider in understanding how morphology supports word reading and comprehension. *Transparency* refers to the degree to which the sound and meaning are predictable from the morphemes. *Productivity* refers to how often a morpheme is used to create a new word. For instance, the prefix *re-* is used often to create new words and is highly transparent (it is always spelled the same and it always means *again*). Words with higher transparency and higher productivity are more helpful in word decoding than morphemes that have lower transparency and productivity.

2.7. Structuralism & Connectionism

One of the fundamental problems in the study of language processing is how to define words and their components. Morphemes are largely treated as discrete units that are represented in long term memory and used as such in language processing. Words like *baker* and *talker* are thought to have two morphemes each, with the *-er* suffix in common. It seems intuitively correct that in the course of morphological processing, these units get analyzed, synthesized and stored as such. Words like *kangaroo* or *toilet*, have no roots so these words would be processed and stored as whole units. The idea that morphemes are defined as minimal meaning-bearing units, arrayed much like beads on a string (Hockett, 1958), combined and recombined in rule-governed ways is the hallmark of Structuralism. Many morphologically complex words do have a transparent structure, with one-to-one mappings between morpheme and meaning. We run into deeper, muddier waters before long, however, with words like *grocer* which is

superficially similar to *baker* or *talker*, but for the fact that *groc-* is not a root and *-er* does not modify *groc-* (someone who *groces*) as it does *baker* (someone who *bakes*) (Gonnerman, Seidenberg & Andersen, 2007). The difficulty then, is to ascertain the basis upon which morphological processing and lexical storage occurs given the fact that words like *grocer* and *baker* have superficial orthographic similarities but differing phonological and semantic structure.

Alternatively, the connectionist approach argues for a *graded* definition of morphemes which is less restrictive. Connectionists (e.g., Aronoff, 1976; Henderson, 1985; Rueckl, Mikolinski, Raveh, Miner & Mars, 1997; Li & MacWhinney, 1996) have pointed out phonological and semantic code overlaps in many words and argue on this basis that the definition of morphemes entails more than the notion that they are minimal meaning-bearing units. Another good example that highlights the problem of morphological gradation is the group of words: *strawberry*, *blueberry* and *blackberry*. All three words have *berry* in common. The morpheme *berry* has the same semantic representation in each word and all three words are modified by the preceding morpheme. Blueberries are indeed blue, blackberries are indeed black, but given the fact that *straw* has no bearing on the colour, shape, texture or taste of the berry, *berry* is being modified by what? What consequences does this semantic aberration have for the processing of morphological forms of berry types or the morpheme *straw* for that matter?

Gonnerman, Seidenberg and Andersen (2007) point out that theories of morphological processing have largely focused on words that are represented in terms of discrete components, where there are transparent, one-to-one mappings between form and meaning. Any theory of morphological processing and awareness must account for the deviant cases as well, where phonological and semantic overlaps means that words may be recognised, processed and manipulated differently, depending on the type and degree of deviation. Recent investigations have been useful in teasing out the nature of morphological representation in long term memory and thus providing a clearer definition of the morpheme concept.

2.8. Morphological Representation in the Lexicon

Since morphemes have phonological, orthographic and semantic properties, psycholinguistic research on visual word processing has sought to elucidate the basis on which multi-morphemic words are perceived and represented in long term memory. The Orthographic Depth hypothesis (Frost, Katz & Bentin, 1987) suggests that for languages such as English which have deep orthographies (i.e., the correspondence between graphemes and phonemes are inconsistent), the recognition of morphemes may have the important role of helping readers assign correct word pronunciations (Verhoeven & Perfetti, 2003).

Researchers have employed a variety of priming paradigms in lexical decision tasks to investigate the existence of and mechanisms behind morphological decomposition in adults. Priming paradigms fall into two categories. In *fully-visible* priming paradigms the prime word is simply presented for a predetermined number of milliseconds. In *masked priming* paradigms, the prime is presented for a very brief duration (40-50 ms) and sandwiched between forward and backward masking stimuli such as hash marks (####). The object of masked priming is to reduce the visibility of a stimulus with the aim of measuring unconscious influence (Lleras & Enns, 2005). Murrell and Morton (1974) were the first to use identity and morphological priming to show that repeated words and morphologically related primes were identified more readily than unprimed words and subsequent research has shown that responses to words are facilitated by the presentation of morphological primes (Fowler, Napps & Feldman, 1985; Stanners, Neiser, Herson & Hall, 1979).

There are four broad theories of morphological representation in long term memory. The first theory is that multi-morphemic words (e.g., *jumping*) are stored in long term memory as a whole lexical entry (or *full-listing*) (e.g., *jumping*) (Feldman & Fowler, 1987). A second theory is that multi-morphemic words are represented through *decomposition* (Taft & Forster, 1975), whereby words are analyzed into their constituent morphemes (*jump* + *ing*) during visual word perception. This theory was later reformulated into the interactive-activation model (McClelland & Rumelhart, 1981) and then into an understanding of morphological decomposition as a higher-level function

that is guided predominantly by semantic knowledge (Marslen-Wilson, Tyler, Waksler & Older, 1994). Dual-route accounts hold that morphemes are explicitly represented and accessed over the course of visual word recognition. Some multi-morpheme words are represented in terms of their constituents and others are represented as whole words. Whether words are represented as whole entities or are decomposed depends on the frequency of both the word and its morphemes (Caramazza, Laudanna & Romani, 1988) or the phonological and semantic transparency of word and morphemic components (Baayen et al., 1997).

The fourth model, a connectionist model, holds that multi-morphemic words are represented in distributed patterns of activation that “are more-or-less componential in a way that reflects morphological structure” (Rueckl & Galantucci, 2005, p. 116). This model assumes that morphemes reflect regularities between orthographic and semantic levels of representation (Gonnerman, Seidenberg, & Anderson, 2007; Plaut, 1999; Plaut & Gonnerman, 2000; Rueckl, Mikolinski, Raveh, Miner, & Mars, 1997). Psycholinguistic researchers widely agree that multi-morphemic words are decomposed into their constituent morphemes (Rastle & Davis, 2008; Frost, Grainger & Rastle, 2005) but there is little consensus in the field on how and when the recognition system decomposes printed stimuli. However, across both perspectives, morphological priming is thought to have a transfer effect. Information from the shared base morpheme is transferred from the prime to the target word and the speed with which this happens is taken as evidence of the implicit organization of morphological knowledge (Schiff, Raveh, & Figchel, 2012).

Words such as jumping (*jump + ing*) and replay (*re + play*) are said to have a *transparent* semantic representation because each morpheme represents both an orthographic and semantic unit (adding the prefix *re-* to the verbs *play* and *do* in both cases means *to execute the action again* (i.e., *play again, do again*). The morphological boundaries in these words are clear so it seems logical that words would be decomposed along these boundaries during visual word processing. The question of decomposition becomes more troublesome when we consider a word like *reward* because it is difficult to think about it as consisting of the morphemes (*re-*) + (*ward*). Words like *reward* and *corner* (like *grocer*) are said to have an *opaque* semantic relationship (e.g., *re- + ward* does not mean *to ward again*; *corner* does not mean

someone who corns) since the morphological form does not map neatly onto a semantic representation.

Theories of morphological decomposition that privilege semantic representation are derived from research based on fully-visible primes. For instance, the supralexical theory of Giraudo and Grainger (2000) posits that morphologically complex words are decomposed only if they are related in meaning to their stems; multi-morpheme words with no semantic relationship with their stems (e.g. *corner*, *pickle*) are represented as full forms. Experiments using fully-visible priming paradigms (e.g., Meunier & Longtin, 2007; Rueckl & Galantucci, 2005; Drews & Zwitserlood) show that segmentation is contingent on the semantic relationship between morphologically complex forms and roots but that the relationship must be semantically transparent (e.g. *departure* – *DEPART*). When the semantic relationship is opaque (*apartment* – *APART*) there are no facilitation effects. However, the research done using masked priming paradigms reveals that morphological processing is facilitated in *both* semantically transparent (*darkness*–*DARK*) and opaque conditions (*corner* – *CORN*) and the priming effect in both conditions is considerably larger than in conditions where primes and targets have a non-morphological orthographic relationship only (e.g., *brothel* – *BROTH*) (see Rastle & Davis, 2008, for review). Semantic theories of morphological processing fail to explain the equivalent facilitation for both opaque and transparent conditions because they assert that words with opaque semantic relationships are not decomposed.

Researchers must reconcile the reason why semantic transparency influences morphological decomposition when primes are consciously perceived but has no influence on decomposition when primes are masked. In their review of visible and masked priming experiments, Rastle & Davis (2008) showed that masked morphological priming effects emerge whenever the prime *appears* to have a morphological relationship with its target. In recent work, Rastle and colleagues (Lavric, Rastle & Clapp, 2010; Davis & Rastle, 2010) found a biphasic pattern of priming in opaque multi-morphemic words and assert that morphological decomposition occurs in two stages. In the early stage of visual word processing, the appearance of morphological structure accounts for the observed priming and at the later stage, semantic transparency plays its part in processing. Consistent with Taft and Forster (1975), Rastle and colleagues

suggest that there is “a single, orthography-based mechanism of morphological decomposition licensed at a late processing stage over a two mechanism (orthography-based plus semantically-based) decomposition account” (Lavric, Rastle & Clapp, 2010, p. 684).

2.9. Morphological Processing and Priming in Children

The majority of studies of morphological priming have been conducted with adults but due to the increasing body of evidence linking explicit morphological awareness to positive literacy outcomes (e.g., Singson, Mahony & Mann, 2000; Nagy, Berninger & Abbott, 2006; Carlisle, 2003; Reed, 2008, Goodwin & Ahn, 2010), there has emerged a small but compelling corpus of research in recent years on morphological processing in children. Linking theories of priming with theories of reading could prove to be valuable in understanding, at least in part, the cognitive architecture underlying literacy processes.

Deacon and Bryant (2006) used a priming-type paradigm with clue and no-clue conditions to see whether clue words (primes) helped 7 to 9-year-old children spell multi-morpheme words. Since *turn* is related to *turning* both orthographically and semantically, they hypothesized that students would spell the morphologically related clue words more accurately and indeed, spelling accuracy scores were higher for inflected words than for control words. Results also showed that children as young as 7 years of age are sensitive to morphological information. Notwithstanding the lack of experimental control for prior lexical knowledge or spelling ability, it is of note that the morphologically-related clue primes facilitated word spelling over unrelated primes.

One of the first morphological priming studies conducted in children was by Casalis, Dusatoir, Cole & Ducrot (2009) who investigated whether morphological information is activated in word recognition in grade 4 students. Using a lexical decision task with derived French words, primes were orthographically, phonologically or morphologically related and differed across prime duration conditions (75ms and 250ms). The researchers found evidence of priming in the morphological and orthographic conditions and across durations; there was significant facilitation at 75ms

for both orthographic and morphological conditions but at 250ms, only the morphological condition produced facilitation. Again, although the data come from a French sample – French has a more transparent orthography than English - this is an intriguing finding that may corroborate Rastle's theory that morphological decomposition happens early in processing and on the basis of orthography.

In a later priming study in grade 3 and 5 French students, Quemart, Casalis and Duncan (2012) found that children are sensitive to morphological information in both real and pseudowords as early as grade 3. In the experiment both bases and suffixes were manipulated to investigate which one influences visual word recognition (of French words). The presence of a base or suffix increased the likelihood of children categorizing words as real words. Since words were matched for sublexical features, the authors concluded that contrary to the idea that emergent readers analyze frequent combinations of letters to develop representations for morphemic units (Rastle and Davis, 2008), that suffixes have a "special status for the word recognition system" (p. 437) and that the presence of suffixes, as described by Rastle, do indeed offer islands of regularity which are reliable clues in lexical decision.

In their study of children's sensitivity to morphological information during word reading, McCutchen, Logan and Biangarde-Orpe (2009) sought to link morphological priming paradigms with natural reading in grade 5 and 8 students using a continuous lexical decision task (in which n is a prime for $n + 1$). The students also completed a literacy battery. The researchers found a significant effect of the morphological prime condition but no interaction between prime type and reading skill. This was an unexpected result; if highly skilled reading is attributable to sensitivity to morphemes then there should be a higher degree of difference between the average and high-skill reading groups. A two-block hierarchical regression showed that the children were sensitive to the morphological structure of words during word reading but still found no differences between groups on reading skill and explicit morphological knowledge.

Findings from a number of studies have shown that base frequency and phonological transparency of the base form are likely to be important factors in accessing the morphological structure of words (e.g., Carlisle, 2000; Mann & Singson,

2003; Carlisle & Stone, 2005). Deacon, Whalen & Kirby (2011) conducted a priming experiment to investigate the respective roles of frequency and phonological transparency in recognizing derived words in students in grades 4, 6 and 8. Across grade levels, accuracy and speed in word reading was affected by the morphological structure of words. Children were faster at reading derived words with high base frequencies when the words had low surface frequency (e.g., *close/closure*). Effects of frequency and transparency of bases only had an effect on word reading accuracy for the younger students in grades 4 and 6; for grade 8 students, morphemic processing probably can be seen in reading speed only, although the authors admit the data is not conclusive due to ceiling effects in the grade 8 data. Interestingly, this finding might also help to explain the surprising findings in the McCutchen, Logan and Biangarde-Orpe (2009) study. Prime type may not be as important in the reading accuracy of more mature, skilled readers who have to exert less effort in morphemic segmentation.

Rabin and Deacon, (2008) studied children in grades 1 to 5 and Deacon, Campbell, Tamminga and Kirby (2010) studied children in grades 4, 6 and 8 using fragment completion tasks to test the strength of morphological priming. In both studies it was found that morphological priming effects were equally strong for inflected and derived transparent words and that the strength of priming effects did not change across the grades.

2.10. Morphological Awareness and Literacy Outcomes

Psycholinguistic research on morphological processing has investigated implicit morphological knowledge using tasks to exploit automatic or subconscious linguistic and lexical processes. Tasks such as lexical decision do not require the conscious identification of morphemes. Conversely, literacy research has focused on the explicit, metalinguistic awareness of morphological information in domains such as word identification, reading comprehension, writing and vocabulary development. This vein of applied research has sought to answer a number of questions. Is morphological awareness a unique construct or is it a variation of phonological awareness? What implications does an awareness of internal, meaningful word structures have for

reading? Does morphological awareness vary with reading skill? Finally, what is the specific relationship between morphological awareness and reading comprehension?

2.10.1. Early Investigations

Berko (1958) conducted the earliest study of morphological awareness in young children with the goal of understanding what children internalized with their exposure to English morphology in spoken language. She sought to discover "the psychological status of a certain kind of linguistic description" (p. 150). She devised a series of tests using pseudowords in productive analogy tasks to test children's knowledge about the rule-based ways that morphemes are combined (e.g., "This man knows how to *gling*. He did the same thing yesterday. Yesterday he _____," and children had to fill in the correct response). Based on these responses, Berko argued that preschool children have explicit awareness of inflectional morphemes. However, when children were asked to make singular nonsense words into plurals (e.g. *niz* – *nizzes*) or present tense verbs into past tense (*mot* – *motted*) they were unable to do so. Likewise, the majority of children failed to form a new noun by adding *-er* (e.g., *zib* – *zibber*). Berko's work has been seminal in the study of morphological awareness because it highlighted the idea that in spoken language, morphological awareness can be both implicit and explicit (manipulated strategically for a purpose).

In a longitudinal study, Brown (1973) studied the spontaneous speech between children and their mothers at home for two hours a week over several years. Brown coded his voluminous data for phonetic and morphemic features and discovered that children acquire 14 grammatical morphemes in a consistent order at predictable stages.

Table 2.1. Order of Acquisition of Grammatical Morphemes (Brown, 1973)

Order	Morpheme	Example
1	Present progressive	I driving
2 – 3	Prepositions	in, on
4	Plural	cats
5	Irregular past tense	broke, fell
6	Possessive	Daddy's chair
7	Uncontractible copula	This is hot
8	Articles	a, the
9	Regular past tense	She walked
10	3rd person present tense, regular	He works
11	3rd person present tense, irregular	She does
12	Uncontractible auxiliary	Ross is winning
13	Contractible copula	He's a clown
14	Contractible auxiliary	She's drinking

They begin using two-morpheme words and inflections in their third year, with the development of derivational morphemes following close behind. He also discovered that acquisition of morphemes is linked with mean length utterance (MLU), a measure of linguistic productivity calculated by collecting 100 utterances and dividing the number of morphemes by the number of utterances. A higher MLU is taken to be an indication of higher language proficiency. deVilliers and deVilliers (1973) confirmed that MLU was a better predictor of the acquisition of 14 morphemes than chronological age and verified that once children begin adding grammatical morphemes, the order with which the morphemes are added is remarkably invariant. Lahey, Liebergott, Chesnick, Menyuk & Adams (1992) showed that while there is considerable variability in the beginning stages of morpheme acquisition, by the time children reach 4 years of age and MLU reaches 3.5 - 4.0, all 14 morphemes have been acquired. Interestingly, children with various types of language delay (with lower MLU) have been found to acquire the 14 morphemes identified by Brown but at a slower pace.

Following on this early evidence of the emergence of morphemes in oral language, researchers began to investigate how morphological awareness ability in oral language might be related to achievement in reading, spelling, writing and comprehension. Brittain (1970) found a relationship between inflectional performance

and reading achievement for students in grades 1 and 2 that existed independent of intelligence. On the basis of this finding, it was argued that the ability to produce inflectional endings for nonsense words in sentences indicated a specialized semantic and grammatical knowledge. Gleitman and Rozin (1977) carried the idea further, arguing that learning to read *requires* an explicit awareness of the structure of language, which develops by making implicit knowledge of how to speak explicit.

2.11. Morphological Awareness in Young Children

The first words babies speak are morphemes, the smallest units of meaning. Young children quickly learn how to combine, recombine and infer meanings of new words, building up increasingly sophisticated form-meaning relations (Carlisle, 2007). The fact that morphology is *productive* means that children are able to invent words by combining morphemes to identify objects and actions. As children encounter new words, they develop a mental representation of both base words (e.g., *love*) and bound morphemes (e.g., *-able* in *lovable*) (Schreuder & Baayan, 1995). By the time children start school at age 5, they are morphemic experts at an implicit level of spoken language (Nunes & Bryant, 2006) and over the course of learning to read, write and spell, they learn the ways that print represents spoken language at phonemic, morphemic and syllabic levels.

Nunes, Bryant and Bindman (1997) studied the ways that children learn to spell the inflectional ending *-ed* and identified five discrete stages of development. First, spellings are unsystematic. At the second stage, endings are spelled phonetically (e.g., *kist* for *kissed*). At the third stage, children spell the *-ed* ending with overgeneralization to irregular and nonverb (e.g., *sofed* for *soft*) and in the fourth stage, children generalized to irregular verbs (e.g. *sleped*) but not for nonverbs (e.g., not *sofed*). Finally, in the fifth stage, children used the *-ed* correctly for the regular past tense. In a similar study with French schoolchildren, Fayol, Hupet and Largy (1999) studied the spelling development of plural nouns, adjectives and verbs. Likewise, they were able to identify four stages in a developmental sequence that followed the same unsystematic – overgeneralization – refinement pattern of learning. These two studies taken together demonstrate that over the course of exposure to print and being called upon to

manipulate spellings according to spoken words, children become more aware of inflection distinctions not only in print but in spoken language as well (Nunes & Bryant, 2006).

A number of studies have shown young children to have at least an emergent ability to analyze morphologically complex words. As Carlisle (1995) showed, even as young children gain basic reading skills in grades 1 and 2, the ability to judge morphologically related words and reading ability are highly positively correlated. Carlisle & Fleming (2003) conducted a study with grade 1 and 3 children to examine how children defined morphologically complex words. The researchers asked children to define isolated words and how they would be used in sentences. They found that grade 3 children were better at determining whether a word (e.g. *pinned* or *wind*) can be decomposed and that children were likely to decompose and define words that had a familiar base form such as *still* in *stillness*. An unfamiliar suffix (e.g., *-let* in *treelet*) prevented children from recognizing the familiar base word *tree*. In fact, only 10.8% of grade one students mentioned the word *tree* in their definition and most commented that they "did not know" or "had never heard" the word *treelet*.

From Grade 3 onwards, children typically begin encountering increasing numbers of morphologically complex words. It has been estimated that approximately 60% of these words have a relatively transparent morphological structure (Nagy & Anderson, 1984). Children begin analyzing new words according to their morphological constituents and process these constituents on the basis of their semantic representations (Templeton & Morris, 2000; Verhoeven & Carlisle, 2006). As they get older, the skill with which they learn to analyze derived words improves (Lewis & Windsor, 1996; Wysocki & Jenkins, 1987; Tyler & Nagy, 1989) and well into grade 8, children are still developing and refining their use of derived forms (Freyd & Baron, 1982).

As both Nunes and Bryant have demonstrated over the course of their research (Nunes & Bryant, 2006; Nunes, Bryant & Bindman, 1997b), an implicit knowledge of morphemes used in everyday language is no guarantee that children can make use of morphological information in literacy tasks. Explicit (*metalinguistic*) knowledge of morphemes enables children to attend to, reflect upon and make use of morphological

information over the course of word decoding and text comprehension. For instance, morphological information signals differences between spoken and written word forms (e.g., *feeled* is an invalid word form while *field* is not; the *-ed* suffix is differentiated phonemically in the words *jumped*, *landed* and *banged* but not morphologically) but unless they have *explicit* knowledge of morphemes, the way they interact with phonemes and constrain orthography, children fail to use morphological information to read and spell.

Berninger, Abbott, Nagy and Carlisle (2010) measured the growth in phonological, morphological and orthographic awareness from grades 1 to 6 to show how these contingent skills develop through the course of exposure to print and development of more advanced reading ability (including the shift from learning to read to reading to learn). They showed that word-level phonological and orthographic awareness show the greatest growth in the early elementary years. Morphological awareness showed the most dramatic growth in the first three grades and for decomposition, the highest growth occurs in grade 4 and beyond. The researchers showed that morphological development has a fairly long trajectory and surmised that literacy support for morphological awareness should be ongoing throughout elementary school.

2.12. Is Morphological Awareness a Unique Ability?

Spoken words are organized along phonological, morphological and syllabic lines and change in the English lexicon has historically been driven largely in the morphological domain (Burchfield, 1985). It is intuitively appealing to conclude that (a) speakers of morphophonemic languages who show a consistent developmental trajectory of morphological growth in spoken language and (b) who are able to manipulate words along morphological lines in speech from an early age have some ability to reflect upon and manipulate the morphemes in words once they begin to acquire an understanding of orthographic conventions that capture those linguistic features.

Anglin (1993) studied vocabulary growth and found that the number of derivations grade 5 students knew far outstripped the number of basic words that they knew. He argued that the basis for this dramatic increase in knowledge of derivations is *morphological problem solving* which refers to children's inferences about word meanings based on the analysis of the meanings of the morphemic constituents. Nagy and Anderson (1984) have similarly argued that the dramatic increase in lexical knowledge from grade 4 onwards is attributable to students' ability to recognise and exploit morphological relationships between words. To some extent, individuals process words in a morphological way, but an important question is whether morphological awareness is a unique ability or whether it is just "more phonological" (Deacon & Kirby, 2004). Conceptually, phonological and morphological domains are treated independently, but as mentioned throughout this review, there is considerable overlap between the three domains. To understand reading development, it is important to demonstrate both their independence and relative contributions to reading processes so that, for instance, we understand morphological problem solving in terms of awareness of morphemic structure but also how those structures can be understood as being comprised of sounds and how the consistency of spellings yields predictability in understanding word form and meaning.

Few studies have been conducted to investigate the relative influences of phonology, morphology and orthography in reading but a growing body of research shows that morphological awareness (MA) makes a unique contribution to literacy outcomes.

Carlisle (2005) and colleagues (Carlisle & Nomanbhoy, 1993) showed that morphological awareness independently contributed 7% of the variance in decoding and 10% in reading comprehension in grade 2. Nagy, Berninger and Abbott (2006) found similar results for older students. They used structural equation modeling to evaluate the respective roles of morphological awareness, phonological memory and phonological decoding to reading comprehension, vocabulary, spelling and decoding rate and accuracy in students from grades 4 to 9. Morphological awareness made a strong and unique contribution to word decoding *accuracy* for students in grades 4 and 5 and to word decoding *rate* in grade 8 and 9 students. Morphology also made a unique

contribution across all grades in spelling. The authors corroborated emergent findings in the field, indicating that the period between grades 4 to 9 is “a developmental period in which students are discovering, and refining their knowledge of morphological aspects of the writing system” (Nagy et al., 2006, p. 141).

Deacon (2012) also tested the relative contribution of phonological, orthographic and morphological awareness on early real and pseudoword reading in students in grades 1 and 3 and found corroborating evidence of an independent MA construct. The contribution of phonological awareness was consistently greater than orthographic processing and morphological awareness but morphological awareness was still found to have an independent contribution across both grades and for both real and pseudowords.

In terms of reading comprehension specifically, several studies have demonstrated that morphological knowledge makes a unique contribution to passage-level comprehension, particularly beyond grade 5 (e.g., Carlisle, 2000; Katz, 2004). Droop and Verhoeven (2003) and Nagy et al. (2003, 2006) found that morphological awareness is a significant causal factor in reading comprehension independent of phonological awareness and vocabulary knowledge. McCutchen and Logan (2011) found that morphological awareness accounted for unique variance in vocabulary and comprehension in grade 5 and 8 students.

2.13. Morphological Awareness in Typical and Learning Disabled Students

Morphemes form *islands of regularity* (Rastle, Davis, Marslen-Wilson & Tyler, 2000) in the mapping between orthography and meaning. Given that morphology plays a role in word decoding and recognition, students who gain sensitivity to morphological information in words would have an advantage in decoding and inferring meanings of unfamiliar words (Carlisle, 2003). Researchers have been interested in whether there are differences in ways that typical and learning disabled students exploit morphological regularities and whether they are even perceived as such. Many studies now show that

there is indeed variation in how readers of different skill levels attend to, process and use morphological information in reading tasks.

In a study that investigated word reading of both transparent and non-transparent multi-morphemic words in poor and typical readers, Carlisle, Stone and Katz (2001) found that word reading accuracy was higher for transparent words and that the difference between the two word types was pronounced for the poor readers. Subsequently, Carlisle and Stone (2003) investigated whether reading morphologically complex (but transparent) words (e.g., *winner*, *shady*) was harder for typical and poor readers in grades 4 to 6 than reading other words with two or more syllables (e.g., *dinner*, *lady*). All students were more accurate on the multi-morpheme words than the single morpheme words which showed that morphemic constituents facilitate word identification regardless of skill level. However, accessing morphological representations of derived words was impeded in shift words - words that undergo a phonetic shift in derived forms (e.g., *nature/natural*, *magic/magician*) - particularly for dyslexic students for whom phonological shifts interfered with the ability to perceive morphemic consistency.

Henry (1993) measured students prior to a reading intervention designed to explicitly teach grade 3, 4 and 5 students code-based reading strategies of Latin and Greek root origins and spellings. Before the intervention even the good readers had little to no explicit knowledge of morphological structure (i.e., they were unable to select common prefixes, roots and suffixes from target words). Post-tests showed that single word decoding improved and students were able to analyze words of Latin and Greek origins into their component morphemes and make inductions about meanings of unfamiliar words. Similar studies have shown that students who receive morphophonemic training linked to word origin improved in reading and spelling more than those who were only instructed in basic sound-symbol correspondences (e.g., Lovett, 1999; Lovett, Lacerenza & Borden, 2000; Abbott & Berninger, 1999).

2.13.1. Morphological Awareness in Dyslexia

Individuals with dyslexia exhibit poor performance in recognizing printed words, spelling and reading comprehension (Snowling, 1980). The prominent view is that the core problem in dyslexia is the inadequate representation and use of phonological information that is essential for learning sound-symbol correspondences (Stanovich, 1990). Children with dyslexia show lower awareness of linguistic features of words (e.g., phonological, morphological) and perform worse on most morphological tasks (Fowler & Liberman, 1995). Raveh and Schiff (2008) studied priming in adult dyslexics in Hebrew and found that visual priming was absent when the prime and targets shared a morpheme. Dyslexic students with relatively good performance in an orthographic judgment task exhibited repetition priming but not morphological priming. Most interestingly, strong repetition and morphological priming effects were found when primes and targets were auditory.

While there is ample evidence to show that knowledge of morphological structures supports word reading from an early age in typical readers, the role of morphological awareness in reading for dyslexic students is more complicated. Poor phonological processing ability is the defining feature of developmental dyslexia (McBridge-Chang, 1996; Wagner, Torgesen, Laughon, Simmons & Rashotte; Goswami & Bryant, 1990). Since morpheme awareness tasks presume phonological awareness and morpheme awareness is highly correlated with phoneme awareness (Mann, 1999), how are morphemes decomposed and used in word reading in dyslexic students? For students who struggle at a phonological level, do richer morphemic representations provide any advantage in decoding and comprehension?

Studies on the metalinguistic awareness of morphemes and their role in word reading show that the intersection between phonology and morphology is the main source of difficulty for dyslexic students. Carlisle (1987) reported that grade 9 students with reading disability disregarded morphemic structure and failed to note the relationship between *magic* and *magician* while producing phonemically acceptable spelling errors such as *magition*, *magishion* or *magishan*. Hanson, Shankweiler and Fischer (1983) noted students with reading disability were able to spell phonemically transparent words such as *splinter* or *plastic* but struggled in spelling words that required

sensitivity to morphophonemic structure such as *condemn/condemnation*. Carlisle, Stone and Katz (2001) used a lexical decision paradigm to investigate the ways typical and dyslexic children processed real and nonwords. Children responded extremely rapidly to illegal nonwords (e.g., *amhparasritic* – *hp* is an invalid letter combination in English) but relatively slowly to legal nonwords (e.g., *deromity*). Since the processing time of real words and legal nonwords were so close, it was thought that orthographic and phonological processing mechanisms were used by the dyslexic students, while typical readers processed the words using a surface-level orthographic strategy.

Berninger et al. (2008) conducted fMRI studies in both normal and dyslexic populations and found a common and unique brain activation for phonological, orthographic and morphological word-form tasks in normal readers; the three word forms share some brain circuits but activate others uniquely. They concluded that the nature of impaired metalinguistic awareness must be taken into account: phonological impairment resulted in dyslexia only, children with poor metalinguistic awareness at the phonological, morphological, syntactic levels had dyslexia *and* reading comprehension impairments.

Morphology as a target for intervention at the word-reading level has been shown to be productive; improving morphological awareness supports struggling readers and dyslexics in word reading and it has been found that individuals with dyslexia use morphology as a compensatory strategy (Casalis, Cole & Sopo, 2004). Abbott and Berninger (1999) taught two groups of students either structural analysis (including morphology) or study skills to students with reading disabilities in grades 4-7 and found that word level measures were sensitive to structural analysis. For instance, on the Word Attack measure, the group who were taught structural analysis advanced an average of 11 months while the study skill group advanced 5 months. Both groups gained equivalently in real word reading but the structural analysis group made the most gains in pseudoword reading.

There is evidence that the relationship between morphology and word reading measures in dyslexic students and struggling readers is closely tied to facility with oral language awareness, similar to the data for young elementary school students reviewed

above. Nagy et al. (2003) conducted a study using structural equation modeling to evaluate the respective contributions of phonological, morphological and oral vocabulary to word reading, spelling and comprehension. They found not only a correlation between word reading and morphology in grade 4 students but that morphology contributes *indirectly* to word reading via oral vocabulary knowledge.

Elbro and Arnbak (1996) found that Danish high school students struggling with reading performed lower on all reading measures except when reading morphologically transparent words (Note: *transparent* here means phonetically transparent and not semantically transparent as in the priming literature). Dyslexic students read faster when presented text morpheme-by-morpheme rather than syllable-by-syllable but once morphologically complex words included phonological shifts (e.g., *magic/magician*), the phonological deficit becomes apparent as reading rate and accuracy decrease (Carlisle, Stone & Katz, 2001; Windsor, 2000). In a subsequent study, Arnbak & Elbro (2000) conducted an oral language intervention targeted at the strategic manipulation of morpheme units with dyslexic students with strong results for spelling measures. They argued that when instruction facilitates the segmenting of complex words into linguistic units, the load on verbal working memory is eased; morphological units enable students to hold larger, semantically and orthographically meaningful units in working memory, which facilitates spelling. Berninger et al. (2008) conducted a specialized writing intervention for students with dyslexia and likewise, found that students in the morphological spelling groups showed greater improvement than those assigned to the orthographic treatment.

An interesting finding in the meta-analysis conducted by Goodwin & Ahn (2010) is that morphological training had the capacity to improve phonological awareness. The authors reasoned that by virtue of receiving instruction in the ways that words are decomposed, struggling readers learn to pay attention to *both* phonological and morphological features of words. Since morphological units are more consistent in terms of orthography and meaning, struggling readers and dyslexics might use morphemes as a bootstrapping technique to gain awareness of the phonological system.

2.14. Morphological Awareness in Reading Comprehension

A discussion of the role of morphological awareness (MA) in reading comprehension is peculiar for a number of reasons. Morphemes have orthographic, phonological and semantic features and they also perform a syntactic function. Since they represent multiple sublexical categories, morphologically complex words straddle the word-based and sentence-based levels of comprehension. Of relevance here is not only the question of the mechanisms behind the development of representation of morphemes (e.g., Schreuder & Baayan, 1995) in terms of the structure of the lexicon in long term memory but how knowledge of morphologically complex words is exploited to make sense of word meanings as well as the syntactic and semantic aspects of texts which are likely to provide a basis for inferring meanings of unfamiliar words (Rego & Bryant, 1993).

Current research has shown that morphological awareness (MA) may contribute to reading comprehension in a number of ways. Vocabulary is one of the best predictors of reading comprehension (Carroll, 1993) and reading is a strong cause of general vocabulary growth (Eldredge, Quinn & Butterfield, 1990). Readers who are able to isolate and manipulate morphemes are more likely to identify and assign meanings to new vocabulary more readily (Carlisle, 2003; Kuo & Anderson, 2006) which facilitates understanding of sentences and larger tracts of text in turn. Having knowledge of a large number of words and their meanings may translate to a stronger ability to understand text and reciprocally, the more individuals read the more vocabulary they acquire.

MA may facilitate reading fluency, the accurate and automatic recognition of words in isolation and in connected text. If individuals are more readily able to recognize word parts, they are likely to be able to recognize both the word and its meaning since morphemes represent both orthography and meaning. Several researchers have observed that knowledge of morphologically complex words and the ability to recognize morphological relationships results in increased fluency by way of improved lexical access (Reichle & Perfetti, 2003), expanded vocabulary (Anglin, 1993; Nagy & Anderson, 1984; Nagy & Scott, 2000) and accurate recognition of morphologically complex words (Nagy, Berninger & Abbott, 2006).

MA may also facilitate the extraction of syntactic information since morphemes offer grammatical cues which are essential in meaning-making. Carlisle & Fleming (2003) found that children in grade 3 were more capable of meaning-driven morphological processing in sentence contexts than grade 1 students but for both groups, morphological analysis in sentences contributed to reading comprehension two years later. In short, since reading comprehension relies on a network of abilities (as shown above), MA must be understood as facilitating reading comprehension in a number of ways since morphemes represent multiple dimensions of language.

Given that morphological awareness (MA) is correlated with and predictive of reading comprehension outcomes across a wide age span even after controlling for cognitive and linguistic factors such as IQ, vocabulary knowledge and phonological awareness (e.g., Carlisle, 1995; Carlisle, Stone & Katz, 2001; Casalis, Cole & Sopo, 2004; Deacon & Kirby, 2004, Nagy, Berninger, Abbott, Vaughan & Vermeulen, 2003), recent studies have turned to threshing out the partially-mediated and multivariate relationships between direct and indirect contributions of MA to different domains of reading comprehension skills.

Guo, Roehrig and Williams (2011) conducted a study in English-speaking adults to investigate the relationship between morphological awareness (MA), syntactic awareness and reading comprehension and whether that relationship is mediated by vocabulary knowledge. They found that MA made an independent contribution to reading skills but that the indirect effect from MA to comprehension via vocabulary was not statistically significant. They also found that syntactic awareness is positively correlated with reading comprehension and that there was a statistically significant indirect effect of syntactic awareness on comprehension by way of vocabulary knowledge. In accordance with Tunmer et al. (1987), the researchers interpreted this finding to mean that readers may be using syntactic clues to acquire new vocabulary (e.g., a reader might use knowledge of syntax to reason that the word *gilded* is a type of adjective).

Kieffer, Biancarosa and Mancilla-Martinez (2013) conducted a study to explore the partial mediation of vocabulary and reading fluency by way of morphological

awareness (MA) in reading comprehension. Their study focused on native Spanish speakers learning to speak English. Multivariate path analysis was used to investigate the unique and indirect contribution of derivational morphology to reading comprehension in students in grades 6, 7 and 8. They found that MA had a statistically significant unique relationship to reading comprehension and that this relationship did not differ by grade. They also found that MA had a significant indirect relationship to reading comprehension by way of reading vocabulary and via passage reading fluency but not through sight reading fluency. The researchers suggested that MA might be strongest in facilitating reading fluency since it helps to coordinate the rapid reading of individual words and in rapidly and accurately parsing the syntactic structures of connected text.

Gilbert, Goodwin, Compton and Kearns (2013) investigated whether multisyllabic reading ability moderates the relationship between morphological awareness (MA) and reading comprehension in poor readers and found that MA was positively related to reading comprehension only for relatively poor multisyllabic word readers. The authors surmised that poor readers with weak lexical representations rely upon morphological information to identify words and comprehend texts whereas better readers (who have stronger lexical representation) "do not consciously rely on morphological information when building text meaning from the individual words because the words themselves carry the meaning" (p. 40).

Chapter 3. Methods

This research used a correlational design to develop a morphosyntactic awareness profile of students struggling with reading comprehension. Survey instruments were used to assess verbal reasoning ability, reading ability and morphosyntactic awareness. The purpose of the design was twofold. The first aim was to predict reading ability from measures of morphosyntactic awareness. The second aim was to then to predict membership in groups of low and average comprehenders using the most parsimonious model of reading and morphosyntactic awareness.

The most desirable sample for any study is a random sample because it has the greatest chance to be representative of the population. Without randomization, the validity of statistical tests can be compromised since computation and the generalization of interpretations of those tests is predicated on principles of random sampling. To the extent that a sample is not random, inferences about the population may be more or less meaningful since the sample may or may not accurately reflect that population (Howell, 2002). The sample of participants was deliberately constructed with the specific purpose of studying aspects of morphological awareness in students struggling with comprehension. Consequently, caution in interpreting the results is advised because they may not accurately represent the population of children across grades 5, 6 and 7 who experience difficulty with reading comprehension.

3.1. Participants

76 students in grades 5, 6 and 7 from three school districts in the Lower Mainland of British Columbia volunteered to participate in the study. Students were recruited from an elementary school and from a university-based summer reading program. A teacher associated with the elementary school who is associated with the Faculty of Education suggested that the author collect data at her school since many of

the children there struggled with literacy. Students for the summer reading program were recruited from local schools based on judgments by their classroom teachers about demonstrated difficulty with reading comprehension. As part of literacy tutoring for the three-week program the students were asked to volunteer to participate in the study.

There were 15 students in grade 5, with an average age of 131.2 months (SD = 4.5), 32 students in grade 6 with an average age of 141 months (SD = 4.9) and 29 students in grade 7 with an average age of 151.7 months (SD = 4.9).

3.2. Procedures

Participants were administered a battery of standardized tests to tap verbal and non-verbal abilities and reading achievement. Testing norms were used to calculate standardized scores for the tests of verbal and non-verbal ability and for the literacy battery. Participants also completed five non-standardized tests of morphosyntactic awareness. By using multiple tests of morphosyntactic awareness, the study aimed to identify which ones are most useful in predicting and grouping children who struggle with reading comprehension. Table 3.1 shows the features and source of each morphosyntax measure.

Table 3.1. Characteristics and Source of Morphosyntax Measures

Measure	Test Type	Source
Derivation	oral, real word	Carlisle, 2000
Decomposition	oral, real word	Carlisle, 2000
Snigged	oral, pseudoword	Nunes & Bryant, 2006
Chickener	written, pseudoword	Nunes, Bryant & Bindman, 2006.
Morphological Production Task *	written, real word	McCutchen, Logan & Biangarde-Orpe, 2009.

* The Morphological Production Task was coded by use (MPTUse) and spelling (MPTSpell).

The tests were administered by the author and a team of undergraduate research assistants who had been trained in the administration of standardized and informal measures of academic performance. Participants were tested individually in quiet rooms for two sessions lasting approximately one hour each. The aural component

of the batteries was administered by the researcher speaking the test items to the participants.

3.2.1. IQ Measures

Verbal Reasoning Participants completed the vocabulary routing subtest of the Stanford-Binet Test of Intelligence (SB5) ($M = 100$, $SD = 15$). They were required to verbally define isolated words (e.g., What is a *puddle*?). Scores ranged between 0 and 2 depending on the accuracy of response according to norm-referenced scoring guidelines in the manual. Raw scores for each measure were summed and converted to a scaled score. The internal consistency reliability coefficient for this test as reported in the testing manual is .96 ($SE = 3.26$).

Non-Verbal Reasoning Participants completed the matrices routing subtest of the Stanford-Binet Test of Intelligence (SB5) ($M = 100$, $SD = 15$). They were shown a series of patterned geometric figures and, from a list of possible figures, had to identify which figure came next in the series. Raw scores for each measure were summed and converted to a scaled score. The internal consistency reliability coefficient for this test as reported in the testing manual is .95 ($SE = 3.05$).

3.2.2. Literacy Battery

Participants completed a battery of standardized literacy measures from the Woodcock-Johnson III Tests of Achievement (W-J III; Woodcock, McGrew & Mather, 2007) and the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen & Rashotte, 1999).

Word Identification. The Word Identification subtest of the W-J III is a measure of oral word identification without sentence context. The measure requires participants to read a list of pronounceable real words accurately. Raw scores were converted to standardized scores for age ($M = 100$, $SD = 15$). The reliability reported in the test manual was .95 ($SE = 3.81$).

Passage Comprehension. Participants were shown passages missing single words that increased in semantic and syntactic complexity. Students had to read the passages to themselves and then provide the missing word. Raw scores were calculated based on number of passages completed correctly and converted to standard scores for age ($M = 100$, $SD = 15$). The reliability for this test is .88 ($SE = 5.12$), according to the testing manual.

Reading Fluency. Participants silently read a series of sentences and circled *Y* or *N* after deciding whether statements were correct or incorrect. The test has a maximum time to completion of three minutes. Raw scores were calculated based on number of sentences answered correctly within three minutes. Raw scores were converted to standardized scores for age ($M = 100$, $SD = 15$). The reliability reported in the testing manual was .90 ($SE = 4.79$).

Phonemic Awareness. The Elision subtest of the CTOPP was used. The task required participants to omit or replace sounds and syllables in a series of 13 words (e.g., Say *silk*. Now say *silk* with the /s/). Raw scores for total number of words correct were converted to standardized scores ($M = 100$, $SD = 15$) The test has a reliability coefficient of .80, according to the testing manual.

Rapid Naming. The Rapid Letter Naming subtest of the CTOPP was used. The task required students to name a series of printed letters as quickly and as accurately as possible. Both the time for completion and number of errors were recorded. Raw time-to-completion scores were converted to standardized scores ($M = 100$, $SD = 15$). The test has a reliability coefficient of (.87) according to the testing manual.

3.2.3. Morphosyntactic Awareness Battery

Five measures of morphological awareness (MA) were used to measure participants' ability to use, spell and manipulate morphologically complex words and their roots in speech and print. Measures tapped MA using both real words and pseudowords in sentence completion tasks. Each measure had been validated in prior studies (Carlisle, 2000; Nunes & Bryant, 2006; Nunes, Bryant & Bindman, 2006; McCutchen, Logan & Biangarde-Orpe, 2009) for which the measures had been designed to

investigate morphological awareness in children. Since the measures are sentence-based, they will be referred to as measures of morphosyntactic awareness to discriminate them from word-based tasks that may not require the coordination of syntactic knowledge.

Morphological Production Task/ Participants read a root word and then a sentence missing the derivation of that root (e.g., *victory/* The soccer team was _____.) Participants were asked to write the derivations of root words so that they were a grammatical fit for the sentences. The task was scored in two ways. *MPTUse* was the score for accurate *use* of the derivation. *MPTSpell* was the score for accurate *spelling* of the derivation. Participants did not receive a point for *MPTSpell* if they did not have a corresponding point for *MPTUse*. In other words, they had to use the derived word and use that word correctly if they were to get a point for spelling. For instance, a number of participants chose words that were a grammatical fit for the sentence, but were completely unrelated to the given root (e.g., *victory/Victorians*), in which case they received a score of 0 for *MPTUse* and 0 for *MPTSpelling*.

Derivation. Participants were read a root word followed by a sentence. The student had to say the derived word that was a grammatical fit for the sentence (e.g., Music. The _____ played beautiful music).

Decomposition. Participants were read a morphologically complex word followed by a sentence. The student had to decompose the complex word into its root word that was a grammatical fit for the sentence (e.g. Musician. The _____ sounded wonderful).

Chickener. Participants read a series of 14 sentences containing pseudowords that were morphologically complex (e.g., *chickener*) for which they had to write a definition. Students received a point if their written definition reflected both components of the morphologically complex word (e.g., a chickener is *a person who* takes care of *chickens*). This scoring method was consistent with the scoring system used in the original study.

Snigged. Participants were read a series of 14 sentences that contained inflections and derivations of the same pseudoword (e.g., Today I will *snig*. Yesterday I *snigged*. Tomorrow I will _____). Students were required to say the correct morphologically complex pseudoword that would complete the sentence accurately (e.g., Tomorrow I will *snig*). Students received one point if they answered correctly.

3.2.4. Word Type

Morphological structure awareness describes the awareness of and access to the structure of morphologically complex words (words consisting of two or more morphemes) (McBride-Chang et. al, 2007). Having morphological structure awareness means that readers acknowledge (either explicitly or implicitly) the mappings between sound, spelling and meaning. The awareness of the idea that morphemes represent both meaning and orthography must, at least to some degree, imply an awareness that different words require different operations in their manipulation. For instance, to derive *swimmer* from *swim*, the student must be aware that an additional *m* is added to spell *swimmer* correctly; deriving *magician* from *magic* involves the awareness of both a sound change in the word ending (/k/ to /sh/) and the addition of the suffix.

Since one of the aims of this study was to investigate whether word type predicted reading comprehension difficulties, and indeed whether some word types prove more troublesome across measures, it was important to account for the types of words within each of the five MA tests. Each word across the five measures was coded by word type, as shown in Table 3.2 below. Scores for word types were then summed across students and measures. To expand upon the research of Nunes, Bryant and colleagues (e.g., 1997, 2006), the word type measures permitted a finer-grained analysis and prediction to help investigate whether students in the sample struggled with particular types of word-based operations in deriving and decomposing morphologically complex words.

Table 3.2. Coding Scheme for Word Type

Label	Word Type	Example
A	tack on (no root or spelling change)	four - fourth
B	total change	deep - depth
C	spelling change (remove a letter)	nerve - nervous
AD	tack on + stress/sound change	know - knowledge
CD	spelling change + stress/sound change	assume - assumption
AC	spelling change (tack on + add a letter)	excel - excellent

Cronbach's alpha was calculated from the data for the morphosyntactic awareness battery and for each of the subtests. The results are shown below.

Table 3.3. Reliability for Measures of Morphosyntactic Awareness

Measure	Number of Items	Cronbach's Alpha
MPT USE	30	.911
MPT SPELL	30	.910
Derivation	28	.844
Decomposition	28	.819
Snigged	10	.563
Chickener	14	.771
Entire Battery	6	.833

Chapter 4. Results

4.1. Distribution and Outlier Analysis

A visual inspection of histograms and Q-Q plots for all measures indicated that scores for measures of IQ, reading and morphosyntax were normally distributed. Skewness and kurtosis were, for the majority, within the range of ± 3 so student performance was judged to be largely normally distributed. The only exception was kurtosis on the Decomposition measure which showed a high positive skew ($Y = 5.34$).

A univariate outlier analysis was conducted by converting raw scores to z-scores. An outlier was considered any score beyond ± 3 standard deviations. There was one outlier on MPTUse ($-3.67 SD$) and two outliers on the Decomposition measure ($-4.14, -3.84 SD$). Before deciding whether to delete or recode outliers, a search for multivariate outliers was conducted. Mahalanobis distance was calculated with $p < .001$ for the reading measures, morphosyntax measures and IQ measures to investigate whether there were any outliers in the multivariate sense. There were none. Consequently, no data was deleted or recoded.

4.2. Missing Data

A missing values analysis was conducted to highlight patterns of missing data. Little's MCAR test showed data was missing at random (MAR). However, less than 5% of the data were missing from the data set and missingness was not related to the dependent variable (Tabachnick & Fidell, 2007). Multiple imputation (MI) was used to replace missing data because it retains sampling variability.

4.3. Descriptive Statistics

Descriptive statistics were calculated for each grade on the IQ measures, literacy battery and measures of morphosyntax as shown in the tables below.

Table 4.1. Means and Standard Deviations on Standard Scores for Measures by Grade

	Grade 5 (n = 15)		Grade 6 (n = 32)		Grade 7 (n = 29)	
	M	SD	M	SD	M	SD
<i>IQ Measures*</i>						
SB5 Vocabulary (Routing)	6.13	3.11	6.74	2.36	7.17	1.83
SB5 Matrices (Routing)	11.00	1.88	9.10	2.61	9.45	1.82
<i>Literacy Battery</i>						
WJWID (Word Identification)	107.13	15.88	99.21	13.16	97.24	10.86
WJPC (Passage Comprehension)	90.66	8.46	88.68	9.00	89.27	8.14
WJRF (Reading Fluency)	105.67	18.37	104.13	16.89	104.79	18.52
CTOPP - Rapid Naming*	11.75	2.31	12.46	2.16	13.05	1.91
CTOPP – Elision*	12.60	2.63	12.45	2.82	12.25	3.06

* Age equivalent

Table 4.2. Means and Standard Deviations for Raw Scores on Measures of Morphosyntax by Grade

	Grade 5 (n = 15)		Grade 6 (n = 32)		Grade 7 (n = 29)	
	M	SD	M	SD	M	SD
MPTUse	22.53	6.08	23.28	5.56	25.17	5.52
MPTSpell	17.47	6.44	17.91	6.88	19.21	7.84
Derivation	15.73	6.69	17.81	5.10	19.45	4.42
Decomposition	22.93	4.30	23.66	3.69	25.31	2.10
Chickener	5.47	2.47	5.78	2.68	6.83	2.71
Snigged	5.53	1.92	5.03	2.17	5.34	1.89

Descriptive statistics were calculated for word type.

Table 4.3. Means and Standard Deviations of Word Type Across Morphosyntax Measures

Word Type	Mean	SD
A	39.75	7.69
B	9.79	3.70
C	11.18	3.05
AC	8.36	1.91
AD	9.70	3.40
CD	12.22	1.91

An analysis of variance was calculated to investigate whether students differed by grade on each of the IQ measures. Results showed there were no statistically detectable differences between groups on the Matrices routing subtest, $F(2, 73) = 2.28$, $p = .10$ or the Vocabulary routing subtest, $F(2, 73) = 2.28$, $p = .69$.

Table 4.4. MANOVA Results Showing Differences by Grade on Measures of Literacy (Standard Scores)

Dependent Variable	df	F	Mean Square	p
Word Identification	2	.38	20.69	.68
Passage Comprehension	2	2.33	30.13	.10
Reading Fluency	2	1.40	439.41	.23
Rapid Naming	2	.84	36.04	.43
Elision	2	.14	1.93	.86

Table 4.5. MANOVA Results Showing Differences by Grade on Measures of Literacy (Raw Scores)

Dependent Variable	df	F	Mean Square	p
Word Identification	2	.38	20.69	.68
Passage Comprehension	2	2.33	30.13	.10
Reading Fluency	2	1.48	439.41	.23
Rapid Naming	2	.84	36.04	.43
Elision	2	.14	1.93	.86

A multivariate analysis of variance was calculated to investigate mean differences between grades on the literacy battery based on standard scores. Results in

Table 4.3 showed that there were no statistically detectable differences between grades. A multivariate analysis of variance was then calculated based on raw scores. Table 4.4 shows that there were no statistically detectable differences between grades for raw scores either. Since there were neither statistically detectable differences for grade on the reading battery measures nor for the IQ measures, the grades were collapsed and all participants were treated as one group.

Table 4.6. Means and Standard Deviations of Word Type Across Morphosyntax Measures

Word Type	Mean	SD
A	39.75	7.69
B	9.79	3.70
C	11.18	3.05
AC	8.36	1.91
AD	9.70	3.40
CD	12.22	1.91

Means and standard deviations were calculated for the reading battery based on the entire group. Results showed that the scores for rapid naming and elision tasks were within the normal range. Word identification scores were in the 50th percentile range while scores for passage comprehension were in the 25th percentile range. It is common to use the 25th percentile as a cutoff for struggling readers (e.g., Fletcher et al., 1994; Stanovich & Siegel, 1994). This group was defined as poor comprehenders following other studies (e.g., Catts, Adlof & Weismer, 2006) that define poor comprehenders on the basis of two features consistent with the Simple View of Reading: (a) dissociation between word identification and passage comprehension scores and (b) phonological awareness ability that falls in the normal range. While this group will be labelled as poor comprehenders, caution should be taken with the classification since poor comprehenders show a wide range of difficulties at both word and discourse levels (e.g., working memory, comprehension monitoring, making inferences). It is possible that poor comprehenders have age-appropriate word *recognition* skills but slower than average word *processing* skills (Cain & Oakhill, 2007; Nation & Snowling 1998b). While there is some theoretical and empirical support for the classification method in this study, it should be acknowledged that it may not be accurate in light of the scope and complexity of the difficulties experienced by children with comprehension difficulties.

Table 4.7. Means and Standard Deviations on Reading Battery for the Sample

Reading Measures	<i>M</i>	<i>SD</i>
Word Identification	100.02	13.27
Passage Comprehension	89.30	8.49
Reading Fluency	104.68	17.59
Rapid Naming	12.40	2.84
Elision	12.54	2.13

4.4. Correlations

Correlations among the variables were calculated to measure the strength of relationship between IQ, reading and morphosyntactic awareness. As one might expect, there was a statistically significant correlation between verbal ability and passage comprehension (WJPC) $r = .54$.

Table 4.8. Correlations Between Passage Comprehension and IQ Measures (n = 74)

Measure	1	2	3
1. Passage Comprehension	–		
2. Verbal ability	.539**	–	
3. Non-verbal ability	.215	.353**	–

** significant at $p < .01$.

The results also showed a relatively high positive correlation between word identification (WJWID) and passage comprehension $r = .68$.

Table 4.9. Correlations Among Reading Measures (n = 74)

Measure	1	2	3	4	5
1. Passage Comprehension	–				
2. Word Identification	.678**	–			
3. Reading Fluency	.514**	.502**	–		
4. Elision	.326**	.534**	.267**	–	
5. Rapid Naming	-.109	-.285	-.289*	-.312	–

** significant at $p < .01$.

Passage comprehension was highly correlated with three morphosyntax measures: MPTUse $r = .67$, Derivation $r = .65$ and Decomposition $r = .65$.

Table 4.10. Correlations Among Passage Comprehension and Morphosyntax Measures

Measure	1	2	3	4	5	6	7
1. Passage Comprehension	–						
2. MPTUse	.672**	–					
3. MPTSpell	.573**	.739**	–				
4. Derivation	.654**	.750**	.593**	–			
5. Decomposition	.646**	.741**	.617**	.763**	–		
6. Chickener	.403**	.407**	.455**	.306**	.320**	–	
7. Snigged	.354**	.328**	.360**	.404**	.405**	.408**	–

** significant at $p < .01$.

Correlations between word type and passage comprehension were mixed. When all word types were summed and correlated with passage comprehension, results showed a high correlation between word type and passage comprehension $r(67) = .71$. Word type AD (words with a stress change such as *know - knowledge*) showed the highest correlation with passage comprehension $r(74) = .70$.

Table 4.11. Correlations Between Passage Comprehension and Word Type

Measure	1	2	3	4	5	6	7
Passage Comprehension	–						
A	.645**	–					
B	.653**	.719**	–				
C	.657**	.807**	.646**	–			
CD	.634**	.779**	.647**	.890**	–		
AD	.701**	.790**	.752**	.780**	.797**	–	
AC	.432**	.669**	.619**	.544**	.531**	.574**	–

** significant at $p < .01$

4.5. Predicting Reading Comprehension from Measures of Verbal Ability, Reading and Morphosyntax

Two multiple regression analysis were conducted to investigate the relative contributions of verbal IQ, word identification and morphosyntax skill to reading comprehension and to understand how morphosyntax skill and word identification skill might vary with comprehension skill independent of one another. Real word measures of morphosyntax were used in both analyses since they showed the highest correlation with passage comprehension. The first analysis was a three block design, as shown in Table 4.8. The real word measures of morphosyntax (MPTUse, Derivation and Decomposition) were entered first. Model 1 predicted 50% of the variance in comprehension scores ($\text{Adj. } R^2 = .50$, $F(3,72) = 25.97$, $p < .001$). Adding verbal ability to the model resulted in an R^2 change of .06. Word identification ability explained an additional 2% of the variance in comprehension scores. It is important to note across all three models, however, that the only variable to reach statistical significance at the $p < .001$ level was verbal ability, after accounting to the measures of morphosyntax skill in Model 2. The results in this first analysis are mixed. While each model was statistically significant overall at the $p < .001$ level, it is difficult to sift out which variables account for variance in reading comprehension since their beta weights vary in statistical significance depending on other variables in the model. For instance, *MPTUse* shows statistical significance in Model 1 and Model 2 but does not reach significance in Model 3, once word identification has been added into the equation; verbal ability is statistically

significant at the $p < .001$ in Model 2, but once word identification is added into the model, it is no longer significant. These results suggested that word identification played a strong role in predicting comprehension scores for this sample so further investigation was conducted.

Table 4.12. Summary of Regression Model for Variables Predicting Reading Comprehension - Morphosyntax

Variable	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²	ΔE^2	<i>F</i>
<i>Model 1</i>						
MPTUse	.21**	.08	.332	.50		25.97***
Derivation	.16	.09	.238			
Decomposition	.23	.14	.215			
<i>Model 2</i>						
MPTUse	.13*	.08	.33	.56	.06	25.32***
Derivation	.07*	.09	.12			
Decomposition	.13	.13	.19			
Verbal Ability	.25***	.07	.29			
<i>Model 3</i>						
MPTUse	.13	.08	.21	.58	.02	22.30***
Derivation	.07	.09	.11			
Decomposition	.13	.13	.12			
Verbal Ability	.22	.07	.26			
Word Identification	.12*	.05	.25			

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

In the second analysis, verbal ability was entered into the equation first, followed by word identification. The model predicted 58% of the variance in reading comprehension (Adj. $R^2 = .58$, $F(5,70) = 22.30$, $p < .001$). Verbal IQ was entered into the first block of the analysis. It explained 28% of the variance in reading comprehension. (Adj. $R^2 = .28$, $F(1,74) = 30.25$, $p < .001$). Word ID was entered into the second block of the analysis. Together with Verbal IQ, 53% of the variance in reading comprehension was explained and both variables reached statistical significance at the $p < .001$ level. Adding Word ID into the equation saw an R^2 change of .25. The morphological

measures contributed approximately a 5% gain over and above the variance explained by verbal IQ and Word ID.

Table 4.13. Summary of Regression Model for Variables Predicting Reading Comprehension – Verbal Ability

Variable	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²	ΔR^2	<i>F</i>
<i>Model 1</i>						
Verbal Ability	.46***	.08	.53	.28		30.25***
<i>Model 2</i>						
Verbal Ability	.27***	.07	.31	.53	.25	40.55***
Word Identification	.27***	.04	.55			
<i>Model 3</i>						
Verbal Ability	.22**	.07	.26	.58	.05	4.28**
Word Identification	.12**	.05	.25			
MPTUse	.13*	.08	.21			
Derivation	.07*	.09	.11			
Decomposition	.13	.13	.12			

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

4.6. Predicting Reading Comprehension from Word Type

A single-block multiple regression analysis was performed to predict reading comprehension from word type. The results of the regression showed that word type predicted 51% of the variance in reading comprehension scores (Adj. $R^2 = .51$, $F(6, 62) = 12.69$, $p < .05$). Of all the word types, AllB (shift words such as *deep - depth*) had the only significant unique association with comprehension ($\beta = 3.13$, $p = .029$).

4.7. Discriminant Function Analysis

The primary goal of discriminant function analysis (DFA) is to find dimensions along which groups differ and to determine classification functions that are most predictive of group membership (Tabachnick & Fidell, 2007). DFA was performed to predict membership in low and average reading comprehension groups based on reading and morphosyntactic awareness scores. DFA is useful for predicting

membership in naturally-occurring groups but because groups have not been formed from a random sample, it is important to interpret the results in light of the theoretical and empirical findings that might explain differential membership.

The sample was divided into three groups using WJPC (passage comprehension) standard scores to identify students with poor and average comprehension ability. A commonly used psychometric conversion table was used to establish cutoffs for average and low average categories (Psychometric Conversion Table, n.d.). A low skill group (WJPC ≤ 87) of 29 students, a middle group (WJPC $88 >$, < 92) of 19 students and an average skill group (WJPC ≥ 93) of 28 students. Normally, students with SS equal to or lower than 89 on the WJPC are considered low achievers while students with SS above 90 are considered average. The middle group was selected based on those criteria because the 88 - 92 SS band straddles the 90 SS cutoff. By removing a middle group from the DFA I could maximize group differences and increase the power of the design. Thus, note that the average skill group was actually the relatively high group. The middle group was excluded from the analysis to maximize differences between groups and to increase the power of the design, leaving 57 participants split approximately evenly across two groups. Since there are two groups in the analysis, there is one function possible.

A direct discriminant function analysis was performed using four reading and morphosyntax variables as predictors of membership in two groups: word identification, reading fluency, Derivation and Decomposition (both oral measures of morphosyntactic awareness). The groups were low and average comprehenders. There were no univariate or multivariate outliers identified. Box's *M* tests the assumption that the variance-covariance matrix of the predictor variables is the same in both groups. Box's *M*, $F(10, 14419.03) = 3.92$, $p < .001$ which can indicate a problem with the data. However, according to Wuensch (2008), this can be disregarded because the sample sizes are roughly equal and while Box's *M* is highly sensitive, the DFA is thought to be very robust.

All four predictors entered the model at once so each predictor was assigned only the unique association it had with each group (Tabachnick & Fidell, 2007). A single

discriminant function was calculated. The F of each predictor was highly statistically detectable which shows there is a statistically measurable separation of the two groups based on the four predictors combined.

Table 4.14. Means (SD), ANOVA and Wilks' Lambda Results

Variable	Word ID	R. Fluency	Derivation	Decomposition
Low	50.76 (6.26)	47 (12.04)	14.59 (5.82)	22.07 (4.31)
Average	60.04 (5.38)	64.71 (17.18)	21.04 (3.10)	25.68 (1.90)
F	35.82*	20.42*	26.89*	16.46*
Wilks' Lambda	.606	.729	.672	.770

* $p < .01$.

To investigate whether oral or written measures of morphosyntactic awareness were more predictive of group membership, a similar analysis was performed in which the predictors WJWID, WJRF, and the two oral measures, Decomposition and Derivation were used in the equation.

Table 4.15. Results of Discriminant Analysis based on Reading and Morphosyntax Measures

<i>Eigenvalues</i>				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical R
1	.884	100	100	.685
Test of Function	Wilks' Lambda	Chi-Square	df	Sig.
1	.531	33.57	4	< .001

* WJWID, WJRF, Derivation, Decomposition

The eigenvalue is the proportion of variance explained by the discriminating function. Word identification, reading fluency, derivation and decomposition were strongest in differentiating between the low and average comprehension groups. Wilks' Lambda is the ratio of within groups sums of squares to total sums of squares. It is a test of the discriminant function for statistical difference from the null hypothesis of no difference between these sums of squares. Wilks' Lambda (.531) was detectable showing that the group means differ.

The strongest predictors associated with the discriminant function which distinguishes between the Low and Average groups were the word identification and derivation measures, followed by reading fluency and decomposition. Classification results showed that the cross-validated accuracy rate was 80.7%, greater-than-chance accuracy.

Table 4.16. Standardized Canonical Coefficients and Structure Weights from the Discriminant Model

Variable	Standardized Coefficients	Structure Weights
Word Identification	.650	.858
Reading Fluency	.394	.648
Derivation	.497	.744
Decomposition	-.315	.582

Chapter 5. Discussion

Since Berko's (1958) seminal work on morphological awareness, research has shown that morphology matters in the comprehension of oral and written language. As English is a morphophonemic language, it is plausible that English speakers develop both phonological and morphological awareness. Babies move from uttering sounds to uttering words and these first words are morphemes. Children learn to manipulate words on a morphological basis early in language development (Brown, 1973; Lahey, Liebergott, Chesnick, Menyuk & Adams, 1992; Nunes & Bryant, 2006), and there is evidence to show that as early as grade 1 children have some degree of awareness of morphological structure in printed words (Brittain, 1970; Carlisle, 1995; Carlisle & Fleming, 2003; Carlisle, 2007). However, models of reading and word identification have largely ignored the role that morphology might play in lexical processing (Reichle & Perfetti, 2003). The bulk of research in literacy has been aimed at investigating phonological processing and in developing evidence-based practices for phonological decoding (Muter, Hulme, Snowling, & Stevenson, 2004), partly on the assumption that strong decoding ability will automate word recognition skill and in turn, better reading comprehension since working memory resources can be allocated to constructing meaning and integration rather than decoding. Recent research highlighted that comprehension difficulties occur beyond the phonological core. But there has been little focus on evidence-based practices around word formation which are likely to be critical in fostering literacy achievement beyond grade 4 (Berninger, Abbott, Nagy & Carlisle, 2010).

Two dominant lines of research have explored facets of morphological knowledge. The psycholinguistic literature, which aims to investigate unconscious awareness of morphological knowledge by way of lexical decision and fragment completion tasks, has repeatedly shown that both children and adults experience morphological priming effects (Murrell & Morton, 1974; McCutchen, Logan & Biangarde-

Orpe, 2009; Quemart, Casalis & Duncan, 2012) and that morphologically complex words are decomposed over the course of visual word recognition (Rastle & Davis, 2008; Deacon, Whalen & Kirby, 2011).

Research on the contribution of morphological awareness (MA) in literacy outcomes (see Goodwin & Ahn, 2010 for review), conversely, has sought to elucidate the nature of explicit, metacognitive knowledge about morphological structure that is implicated in reading comprehension (Rego & Bryant, 1993; Deacon & Kirby, 2004; Berninger, Abbott, Nagy & Carlisle, 2010), vocabulary growth (Kuo & Anderson, 2006), reading fluency (Nagy, Berninger & Abbott, 2006) and syntactic awareness (Carlisle & Fleming, 2003). Most studies of MA have used morphological measures in conjunction with other measures of reading such as phonological and orthographic awareness, vocabulary, rapid naming, working memory and grammatical awareness. However, there have been no studies that evaluated the relative strength of one type of MA task over another in predicting reading ability and specifically, reading comprehension.

Typically, reading research has focused on ways students break down words and attack new words using morphological knowledge (e.g., Nagy & Anderson, 1984; Kieffer & Lesaux, 2007). The morphological awareness construct subsumes a number of different skills that may be grounded in either or both oral and written language ability: synthesis, analysis, procedural knowledge in spelling (knowing when, how and what morpheme to use), semantic knowledge (at the lexical and sublexical levels), declarative knowledge of roots and affixes, syntactic knowledge, and awareness of transparent and opaque form-meaning relationships (e.g., Is the *-up* in *ketchup* a morpheme?). Morphological awareness is also characterized by meta-linguistic skill; the skill to reflect on and know the ways that morphological rules govern spelling and meaning formation. Since tasks tapping morphological awareness incorporate any number of these skills, I hypothesized it is possible that specification of morphological task constraints could refine the understanding of the relationship between morphological awareness and reading comprehension.

The goal of this study was to offer a profile of morphosyntactic awareness in students with reading comprehension difficulties and to investigate whether reading

comprehension ability is predicted by word type. Grade 5, 6 and 7 students who struggle with reading comprehension were tested using a measure of verbal ability, five standardized reading measures and five informal measures of morphosyntactic awareness scored for accuracy and coded by word type. This study expands upon current research by distinguishing between written and oral measures and real-word and pseudoword tasks in predicting reading comprehension. Although it is a correlational study, it is an important step, particularly for reading teachers and those interested in measurement problems in reading comprehension. For instance, depending on whether MA is tested using word-based or sentence-based tasks, the researcher could glean a different sense of the nature of a student's morphological awareness and how that awareness is correlated with or predicts reading comprehension (e.g., poor comprehenders who struggle with syntax may not be captured using word-based tasks but they would using sentence-based tasks). Pseudoword tasks (see Snigged and Chickener tasks, Ch. 4) are often used in testing and assessing children for decoding problems and reading teachers wonder whether verbal tests of comprehension (e.g., listening comprehension) can be taken as a proxy for reading comprehension. By specifying the type of morphosyntax measure that best predicts reading comprehension ability, this study sheds light on these types of questions and suggests which methods of testing MA are likely to be helpful in ascertaining whether a student is experiencing problems in the comprehension of text.

The first main finding of the study is that morphosyntactic awareness measures predict reading comprehension, a finding that is consistent with the literature showing that morphological awareness is a significant causal factor in reading comprehension independent of phonological awareness, vocabulary knowledge, verbal ability and rapid automated naming (Carlisle, 2000; Roman, Kirby, Parrila, Wade-Woolley & Deacon, 2009; Droop & Verhoeven, 2003; Nagy et al. 2006; McCutchen & Logan, 2011). All morphosyntactic measures except for *Snigged* ($p = .002$) reached significance and each was easily statistically detected as being non-zero.

5.1. Pseudoword Measures

The second main finding is that the morphosyntax tasks varied in predicting reading comprehension. Although the results were statistically detectable, the pseudoword measures showed the lowest relative beta weights (*Snigged* $\beta = .354$, *Chickener* $\beta = .403$) compared to the real-word measures (MPTUse $\beta = .672$, Derivation $\beta = .654$, Decomposition $\beta = .646$). Various sentence-based tasks using pseudowords have been used to tap morphological awareness (MA) including the seminal work by Berko (1958). Pseudowords (or pronounceable nonwords) are words that follow orthographic rules so they can be decoded, but have no distinctive semantic representation (e.g., *brunk*). Pseudowords are used in tasks for phonological and morphological manipulation because they provide opportunity to observe decoding or morphological manipulation without the semantic cues that might be used to guide that manipulation. Most adults are able to read words with consistent sound-spelling associations (e.g., *flew*) and generalize to pseudowords (e.g., *prew*). Thus, using pseudowords in morphological awareness tasks tests the extent to which an individual relies upon contextual cues to construct meaning for individual words and whether they can generalize morphological rules to novel word forms. Research on learning pseudowords has shown that it is strongly associated with phonological short term memory (Gathercole, Service, Hitch, Adams & Martin, 1999; Gathercole, Willis, Emslie, & Baddely, 1992). Also, research using pseudowords by Bryant and Nunes (2009) has shown that children use morphological information when remembering the sounds of new words. The fact that both the *Snigged* and *Chickener* tasks were less predictive of reading comprehension in the regression analyses and discriminant function analysis suggests students used morphological information to derive and generalize novel morphological word forms to make a grammatical fit with the sentence, but this skill may be less important in comprehending passages of text than the skill to derive and decompose real, morphologically complex words. In other words, requiring students to analyze real words in sentences is more likely to indicate whether a student is struggling with reading comprehension.

This finding is in keeping with the dynamic, experiential base of the Lexical Quality Hypothesis (Reichle & Perfetti, 2003) that relies upon mechanisms of episodic

memory in accounting for linguistic and perceptual variables upon which lexical processing (and thus reading comprehension) are predicated. It is certainly the case that children acquire skill to manipulate morphologically complex words in an abstract manner, grounded in static representations of words (Tenpenny, 1995). However, evidence from this study, the psycholinguistic literature and research on literacy acquisition shows that word-based comprehension processes are more likely grounded in the experience of reading real text. Frequency effects have been shown to determine the manner in which morphologically complex words are decomposed (Caramazza, Laudanna & Romani, 1988) and how meaning and structure of these words is accessed (Carlisle, 2000; Mann & Singson, 2003; Carlisle & Stone, 2005). The more exposures children have to words, the more likely they are to know how to analyze and manipulate them because a higher degree of word experience translates to well-articulated relationships among orthographic, phonological, semantic and in at least some tacit sense, morphological features (Reichle & Perfetti, 2003). Testing reading comprehension ability by using derivation and decomposition tasks based on real words is more likely to demonstrate the extent to which students are hearing, using and reading morphologically complex words because, unlike pseudowords, they are more likely to have come across them in everyday language experiences. Using pseudowords in MA tasks rules out frequency effects and thus variation in reading skill derived from experience with print. While use of pseudowords is more likely a purer test of a student's sensitivity to and use of morphological rules and/or analogies results in this study suggest that skill, when isolated, is the least predictive of reading comprehension skill.

There are two issues of note with the pseudoword tasks. The first issue has to do with the scoring criteria for the *Chickener* task (Nunes, Bryant & Bindman, 2006). The *Chickener* task required students to provide definitions of pseudowords that were embedded in sentences (e.g., *He works as a chickener.*). In the original experiment, students received a score of one point for a correct answer. To score one point on the item, students had to (a) analyze the word (e.g., *foamer*) into its component morphemes (*foam/er*) and (b) write a definition that was inclusive of both morphemes. For instance, the correct answer for *foamer* would be "a person who" (-er) foams (*foam*). There are a number of assumptions underpinning this task which might explain why its scores were relatively low. It pivots on the assumption of a structuralist definition of a morpheme, that

the morpheme is a minimal meaning-bearing unit of language and that those units are arrayed like beads on a string (Hockett, 1958). The idea is that each morpheme has a corresponding unit of meaning and that those meaning units can be combined to generate a sense of meaning for the entire lexical item. Some morphologically complex words maintain discrete form-meaning relationships, but many do not. In many cases, the meaning of a word is not reducible to the sum of its parts. In the example of *foamer*, the sentence, "He wanted his carpet cleaned and telephoned a *foamer*" indicates that a *foamer* would be someone who cleans carpets. In one sense, a *foamer* is someone who cleans carpets and they often do so with foam, but defining *foamer* as someone who foams is an overly literal shade of the term *carpet cleaner* than would be suggested by the sentence. The student then, is called upon to infer between figurative and literal meanings of the word; they have to understand how foam is associated with carpet cleaning. Evidence has shown that students with reading comprehension difficulties struggle with figurative language (Levorato & Cacciari, 1992; Cain, Oakhill & Lemmon, 2005) so that fact that students struggled to such a high degree on this task is not surprising. Of the 14 items in the task, 12 called upon students to make this shift between literal and figurative meaning in order to establish a cohesive definition given the task constraint of including both morphemes in the definition. Furthermore, the two items *afraidness* and *beautiness* could not be broken down into their morphological components in a discrete fashion. The roots, *afraid* and *beauty*, were not problematic. However, the suffix *-ness* is a modifier (bound morpheme) - it exemplifies a quality or state - rather than having meaning in and of itself which again, does not fall into the parameters of the task. None of the students in the sample referred to *-ness* in their definitions of *afraidness* or *beautiness*. Like the *blackberry* - *blueberry* - *strawberry* example (Gonnerman, Seidenberg & Andersen, 2007) discussed earlier, where *strawberry* is the morphologically opaque exception in the series of *berry* words, it is important in task design to acknowledge that *both* bound and free morphemes are learned in the course of language and literacy acquisition. When individuals encounter morphologically complex words in speech or text, activation of the constituent morphemes may or may not occur depending on whether there are representations of the whole word and/or its constituents in long term memory (Carlisle, 2007; Taft & Zhu, 1995).

It is important to account for these features of linguistic processing to address possible questions of construct validity. Since the morphological awareness tasks are largely characterized by words with transparent morphological constituents, inferences about the relationship between morphological awareness and comprehension are limited to those types of words. By defining morphemes in graded fashion, we can understand word-level comprehension processes according to the continuum bounded by transparency and opacity along which lexical and sublexical items lie. This approach would arguably lend more ecological validity since English is characterized by a broad range of morpheme types, individuals have differing activation patterns for morphologically complex words. Moreover, according to the Lexical Quality Hypothesis, there is variation in the degree of lexical quality in word representations. If the task requires students to infer between literal and figurative meaning and to define a morpheme whose meaning only exists by virtue of being bound to another morpheme, or if stringing morphemes together gives rise to a word that bears little resemblance to its components, it is critical to acknowledge that the additional task complexity tests skills beyond the structural analysis of morphologically complex words.

A second issue with the *Chickener* task is that children often provided adequate definitions of the words that did not make mention of each morpheme. For instance, many children answered that a *foamer* is someone who cleans carpets. The answer is consistent with the sentence context (i.e., a foamer *is* a carpet cleaner) but because the scoring method requires that both morphemes be mentioned in the definition (i.e., the definition had to refer to *foam*), no point was given for the item which lowered scores on the *Chickener* task. This task may have been more a test of the student's declarative knowledge of morpheme definitions rather than whether they were able to derive a general sense of meaning for the word and sentence. The results of this analysis then, should be interpreted acknowledging the structuralist assumptions of the task as well as the stringent scoring criteria. The *Chickener* task highlights the point that morphological awareness is aimed toward making meaning which is a concert of conceptual and inferential skills. Carlisle (2003) pointed out that engagement in morphological problem solving requires an awareness of the benefits of using morphology as a decoding strategy in the first place. Simply *knowing* the benefits of word analysis and morphology

provides a metalinguistic benefit to reading, spelling, vocabulary knowledge and comprehension.

By testing whether students can define morphologically complex words solely in terms of their components misses several points. First, comprehending morphologically complex words is not necessarily predicated on analyzing and defining morphemic components. We may understand *some* words in terms of their discrete, transparent, one-to-one morphological mappings (which permits the use of morphemes to generate new word forms such as *Brangelina*) but it is impossible to understand all morphologically complex words this way because words in the English language lie along a continuum of transparency and opacity which in turn means that morpheme meanings cannot simply be memorized as entities in and of themselves. Second, scoring students on the basis of whether they mention both morphemes in their definition undercuts the strategic, metalinguistic aspect of word analysis and may give an artificially impoverished sense of participants' morphological or morphosyntactic awareness because it underestimates the process of *incidental word learning*, the use of inference from the immediate context of the new word to assign meaning. According to Nelson (1996), an essential condition for word learning is the relevance of the word in the discourse in which it is situated. Perceived relevance determines whether the child seeks out more information about a word or not and context cues are likely to work in tandem with morphological cues in the process of inferring meaning. Nagy and Scott (2000) have likewise argued that context and morphology are the two major sources of information available to a reader to make meaning. By forcing students to define a word based strictly on the definition of morphological components, the task scoring yields an idea of whether children are attending to and assigning meaning to both morphemes in the word, but it strips down the process of using context cues because students have to inhibit, for example, the accurate definition "carpet cleaner" in favour of a definition that refers specifically to the morpheme *foam*. In other words, this scoring system reflects the student's ability to attend to and define discrete sublexical components, but it does not reflect the richness of word-learning and meaning-making that relies upon inferential skills that are critical in word-, sentence- and discourse level comprehension processes. Although the *Chickener* measure is somewhat predictive of reading comprehension ability, it is important to refine what aspect of the ability to define pseudowords is

relevant to reading comprehension. The question for future research is what students struggling with reading comprehension do when words like *strawberry* or *afraidness* range toward the opaque end of structure-meaning mappings and how they make inferences based on vocabulary knowledge and form-meaning relationships in speech and text. How would structural analysis be performed in those cases, if at all, and could that analysis be mobilized in terms of improvements in comprehension, fluency or vocabulary acquisition?

The second issue where pseudoword measures are concerned lies in the clarity for the *Snigged* (Nunes & Bryant, 2006) task which proved to be very confusing for the majority of the participants. The *Snigged* task required students to inflect and derive a pseudoword given a sentence context. The sentence contexts varied from one to three sentences in length and the task started with a three-sentence item. After approximately eight students were confounded by the task, the examiners made the decision to begin with item #6 (*This is a zug. Now there is another one. There are two of them. There are two _____.*) which was the shortest item in the task. Approximately 90% of participants after that point required additional guidance on how to do the task. They were given two attempts to get the first item correct (i.e., item #6) before they were asked to move on. After instructing students on that item, all but three students understood the task requirements and moved on to complete the task with reasonable accuracy. The students who did not understand the task after the two prompts completed the task according to what they thought was expected with little to moderate accuracy. *Snigged* was a difficult task for students to understand and required scaffolding using the simplest item, but once they understood the task requirements, they were able to complete it with relative ease. The fact that *Snigged* is an oral task may indicate something about how the manipulation of morphologically complex words in oral language relates to reading comprehension in older children and warrants further investigation in an experimental setting where features such as item length (which may vary with working memory capacity) and task explanation are better controlled.

5.2. Word Type

The reliability with which MA tasks predicted reading comprehension varied with the type of word used in the tasks. For AD type words students had to attend to a sound change in the derivation (e.g., *know/knowledge*). These predicted reading comprehension ($\beta = .701$). These results are consistent with a number of findings that words containing phonetic shifts (e.g., *music/musician*) are challenging for struggling readers (Kieffer & Lesaux, 2007; Carlisle & Stone, 2003; Carlisle, 1987). In other words, cases where derived words bear the least resemblance to their roots are likely to be most problematic for students struggling with reading comprehension. However, it is important to account for the fact that the beta weights for all the word types were statistically detectable with moderate to high effects. Given the finding that word identification explained such a large portion of the variance in comprehension scores for this sample (see discussion below), the finding that word type was predictive of comprehension may be another source of evidence pointing to weaknesses in the word identification and lexical processing domain for this sample of students.

5.3. Word Identification

Word identification was the strongest predictor of reading comprehension ($\beta = .678$), over and above verbal ability, morphological knowledge and reading fluency. Two approaches were taken in the multiple regression analyses to examine the respective roles of the morphosyntax measures, verbal ability and word identification. First, when morphosyntax measures were entered as a single block, the common variance among predictors explained 54% of the variance in reading comprehension whereas none of the tasks alone was statistically detectable. Since the morphosyntax measures were moderately to strongly correlated with comprehension in the bivariate cases, it can be inferred they share variance held in common with reading comprehension.

The second approach was to investigate how the morphosyntax measures predicted reading comprehension given verbal ability and word identification. Three models were calculated. In the first model, verbal ability alone explained 28% of the variance in passage comprehension. When word identification was added as the second

block in Model 2, 53% of the variance in comprehension was explained, an R^2 change of .25. Three morphosyntax measures were entered into the third block for Model 3: MPTUse, Derivation and Decomposition. The third model explained 58% of the variance in reading comprehension scores with an R^2 change of .05. These results indicate that although morphosyntax is predictive of comprehension ability, the morphosyntax measures explain a relatively small proportion of the variance in reading comprehension. Model 2 was thus the most parsimonious; verbal ability and word identification are the best predictors of reading comprehension for this sample.

This finding is in line with a large corpus of research showing that reading comprehension is hindered by poor word recognition skills. (Torgesen, 2000; Rack, Hulme & Snowling, 1993; Goswami & Bryant, 1990; Adams, 1990). Although children who struggle with reading comprehension struggle in domains that are not tied to text (e.g., oral language ability), these results demonstrate two points. The readiness with which children could read isolated words was the best predictor of comprehension ability. Word knowledge and recognition processes account for over half of the variance in reading comprehension ability in this sample.

To further investigate the type of model that best profiles comprehension for this sample, a discriminant function analysis (DFA) was used to discriminate between groups of low and average comprehenders. The goal of DFA is to determine, given pre-determined groups, which continuous variables discriminate between two (or more) naturally occurring groups. Distributions around two centroids are calculated based on a linear combination of predictor variables. The discriminant function is the line parallel to the imaginary line that connects the two centroids representing the combination of predictors (Tabachnick & Fidell, 2007). DFA can be a useful tool for understanding factors underlying naturally-occurring groupings of participants when researchers can explain how group membership was assigned and why the assignment is theoretically or practically important.

Groups were differentiated on the basis on their standard scores on passage comprehension. The sample was divided into low (WJPC ≤ 87), middle (WJPC $88 >$, < 92) and average (WJPC ≥ 93) skill groups according to psychometrically determined

standard score (SS) cutoffs. A high proportion of the variance in the discriminating function (eigenvalue = .884) was comprised of Word Identification, Reading Fluency, Derivation and Decomposition. The loadings in the structure matrix were all greater than .33 (10% of variance) and showed that each of the four predictors moderately to highly correlated with the discriminant function, word identification being the highest at .85.

The results of the DFA show that similar to the findings in the multiple regression analysis, word identification is the strongest predictor of membership in groups of low and typical comprehenders. According to this model, better comprehenders more readily identify words. Without the fluent, automatic identification of individual words and consolidated representations of word forms, poor comprehenders struggle to recognize words and assemble meaning across sentences. The Derivation and Decomposition tasks measured the student's ability to *orally* manipulate morphologically complex words to fit them into sentences. These measures, too, were reasonably strong in predicting morphosyntactic awareness and whether children would be grouped into low or typical comprehension groups. Sentence-based tasks that required students to manipulate morphologically complex words orally (i.e., Decomposition, Derivation) are better predictors of group membership in typical or low comprehension groups.

According to the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), reading comprehension is the product of word identification ability and oral language ability. Individuals must be capable of understanding the language in which the text is written and they must be able to identify the words in text with sufficient speed and accuracy to ensure that meaning-making can occur. In both the regression analyses and DFA, word identification was the strongest predictor of reading comprehension ability. Although decomposition ability showed the highest structure coefficient in the DFA, it is important to remember that, theoretically, morphological awareness is one aspect of word identification and likewise, derivation ability is but one measure of morphosyntactic awareness. While it can be inferred from these results that students in this sample struggle predominantly with word identification and fluency processes, oral measures of derivation are likely to be a useful supplement to measures of word identification and reading fluency in differentiating between poor and typical comprehenders. This is consistent with research by Wysocki and Jenkins (1987) who

found that students in grade 8 were more likely to make use of combined morphological and sentence clues than grade 4 students. Katz (2004) found that for students in grade 4 and 6, the ability to define derived words and to produce the correct derived word for a sentence context contributed to reading comprehension skill. Since morphological processing influences word identification in terms of both decoding and analyzing word meaning (Carlisle, 2007, Nagy & Anderson, 1984) this research illustrates the point that comprehension efforts for these students take place at the word level but on two reciprocal fronts: identification of words and derivation. Since the sample combines students in grades 5, 6 and 7, a prime window of growth in development of morphological awareness (Berninger, Abbott, Nagy & Carlisle, 2010), these results demonstrate that for this sample of struggling comprehenders, the route to better comprehension likely involves improved reading fluency by way of accurate word identification processes that exploit knowledge of derivational relationships in morphologically complex words.

There remains the question of whether the finding that oral measures of derivation and decomposition are a function of morphological awareness as produced by experience with print or whether they are a function of oral language ability, especially given finding's like those of Raveh and Schiff (2008) showing that morphological decomposition can be primed orally but not visually. In other words, does the awareness of morphemes in print produce the ability to derive morphologically complex words in oral language or vice versa?

Logically, awareness of morphological structure emerges from processing oral language; we learn to speak before we learn to read. The issue of directionality of influence between oral and written language is important, especially given that experience with both print and oral language produce better reading comprehension outcomes and that deficits in either domain are problematic. One of the most pernicious difficulties for students who struggle with reading comprehension is that poor comprehension tends to breed a reluctance to read. This has a circularly cumulative effect. The less children like to read, the less they read and the less they read, the less opportunity they have to improve reading comprehension and experience the sense of mastery that would motivate them to read more often. Oral vocabulary has been found to

predict word reading (Nagy et al., 2003) and an oral language intervention targeted at morphemic manipulation was found to improve the word reading in dyslexic students (Arnbak & Elbro, 2000). Taking these findings along with the finding in this study that oral measures of derivation and decomposition more strongly predicted comprehension could indicate that experience with oral language is the more important source of morphological information mobilized in reading comprehension. Over the course of repeated spoken language episodes, representational processes are instantiated (Parisse, 2002); implicit, holistic, content-directed processes of oral language acquisition are transformed into explicit, analytical awareness of word forms and generalized meaning. Language ability in older children includes skill in recruiting differing morphosyntactic structures and using language flexibly for a variety of communicative purposes (Ravid & Tolchinsky, 2002). While we know that derived words make up approximately 40% of unfamiliar words that children encounter in *text* in their late elementary years (Nagy & Anderson, 1984), further research could prove useful in understanding how children encounter morphologically complex words in oral language, perhaps by way of listening comprehension ability (Tong, Deacon, Kirby, Cain & Parrila, 2011) and the ways this knowledge is used to make inferences about word meanings and sentences in print. Some evidence indeed shows that morphological awareness and reading comprehension might be underpinned by the word-level inference-making abilities - inferring the meaning of new words from context (Cain et al., 2004) and consolidating the meanings of new words (Ricketts, Bishop & Nation, 2008). Measures of receptive and expressive vocabulary would help to refine a theoretical account of the relationship between speech and print in morphological awareness but since the ability to make inferences about words has been shown to drive vocabulary acquisition and morphological reasoning, it would be prudent to expand research on the specific inferences made by students in middle and high school.

5.4. Implications for Teaching

For reading practitioners interested in gathering information on whether their students are struggling with reading comprehension at the word level, this research shows that a measure of word identification, reading fluency and oral measures of

derivation and decomposition ability are likely to help them differentiate between typical comprehenders and students who require further intervention.

Knowing whether students are struggling with word level processes (including morphosyntactic awareness) is important for a number of reasons. First, this information can help teachers determine whether the student is engaging in morphological problem solving. That is, whether they might benefit from morphology instruction simply by knowing that meaningful links between words exist and how to look for them (Anglin, 1993). A number of meta-analyses of morphological structure interventions have shown that explicit instruction in the domain of morphological knowledge can have positive impacts in understanding not only morphological structures but phonological, orthographic and semantic relatedness among words as well (Bowers, Kirby & Deacon, 2010). Goodwin & Ahn (2010) found that morphological instruction can help improve reading, spelling and vocabulary outcomes by focusing on the sublexical level. On the same token, this research shows that by taking measures of word level processes, teachers have the ability to rule out word level difficulties in favor of instruction grounded in discourse level processes such as developing a sense for discourse structure, making inferences or chunking text and concepts to relieve strain on working memory resources.

The measures gathered for this research contain, for the most part, words with discrete morphological structure. In the case of the Chickener measure, the coding scheme in the original study was designed explicitly with a structuralist bias (i.e., the only correct definitions are those that reflect both morphemes, despite the fact that two words on the measure did not lend themselves to this sort of analysis). By posing the question about operations with the acknowledgement that words with sound changes and spelling changes may be more difficult for students struggling with reading comprehension, there is room for a connectionist interpretation that admits morphological structures in everyday reading activities are unlikely to be as transparent as represented in the sample of words.

For teachers, this is an important consideration. Measures with discrete morphological structure are an artificially narrow subset of the types of words typically encountered in English. If it is assumed that all morphologically complex words can be

analyzed into discrete morphemes and we test students on words chosen on this basis then we run the risk of drawing conclusions based on a corpus of words that may inadequately represent the nature of reading, spelling, processing and recalling morphologically complex words. A student may have little struggle with morphologically complex words that have transparent meaning-form relationships but once they encounter words with an opaque relationship (e.g., *ketchup*), Latinate forms (e.g., *abdomen/abdominal*), or words from other languages (e.g., *avocado*), the business of analyzing words according to the component morphemes becomes far more difficult. While using these measures to understand word level processes is a useful starting point in understanding whether children are struggling with reading comprehension, it should be acknowledged that English, as a polyglot language, makes a variety of demands on the ways we develop our vocabularies and understand words and word parts in terms of similarity and difference.

There are implications of this study for students who are English language learners (ELL) since instruction in morphological structure instruction is thought to be helpful with word recognition skills and vocabulary development (Muter, Hulme, Snowling & Stevenson, 2004; Kieffer & Lesaux, 2007). Research on morphological awareness in cross-linguistic populations (e.g., Ku & Anderson, 2003, McBride-Chang et al., 2005) show that the impact of morphological awareness on literacy outcomes varies with the language spoken (i.e., the degree to which the language is described by morphological structures). The impact of these findings in terms of classroom teaching returns us to the issue of structuralist vs. connectionist definitions of morphemes. Morphological instruction is likely to be more effective for students learning English but who also speak agglutinative languages such as Korean or Hebrew in which words are an assembly of morphological component. Although the research in this area is in its infancy, some researchers surmise that children who already speak languages that are structured according to morphemic principles are likely to show a stronger association between morphological awareness and literacy outcomes. Marinova-Todd, Siegel & Mazabel (2013) found preliminary evidence that children whose first language (L1) was highly agglutinative showed a stronger relationship between morphological awareness and reading comprehension but overall, showed lower awareness of English (L2) morphology than their English-speaking counterparts. For teachers then, future research

in this area may point to the idea that teaching and assessing word level process including morphological awareness and understanding the complex dynamics of reading comprehension requires us to acknowledge the influence of L1 in the ways students observe morphological similarity and how they use that knowledge to comprehend both speech and text. The call for measures with both morphologically opaque and transparent forms is echoed here – understanding morphological processes calls upon acknowledgement of the dimensions of the language in which comprehension is taking place.

5.5. Limitations of the Study

Some limitations in the study should be noted. First, results should be interpreted cautiously given the relatively small sample size. Although criteria for sufficient statistical power were satisfied for each of the statistical procedures (in terms of the minimum number of participants) the small sample size means that variances and their errors may be underestimated. A second limitation is that the sample was not random. It was deliberately constructed with the specific purpose of studying aspects of morphosyntactic awareness in students struggling with reading comprehension. Without randomization, the validity of the statistical tests is compromised so although this study has the advantage of a preponderance of students with reading comprehension difficulties, interpretation must be cautious since the group is not representative of the population. Further study with poor comprehenders and typical controls on morphosyntax measures would be desirable to expand the research on the specific constraints of morphosyntax task types and the types of cognitive skills that underpin performance.

Another feature of this study which is both a strength and a limitation is that measures focused on word-level comprehension ability. Thus, the study provides a more elaborate profile of poor comprehenders in terms of these processes. Word-based processes accounted for over half the variance in reading comprehension ability but it would be interesting to investigate how their influence bears out given important processes such as working memory and inference-making ability.

In conclusion, although this is a correlational study, it gives pause to consider the nature and assumptions of morphological tasks used in the literature to measure morphological awareness in children (i.e., that they are predicated on a structuralist definition of morphemes) and how the awareness of morphological structure in oral language in late elementary students is related to literacy outcomes such as vocabulary acquisition, reading fluency and comprehension. Future research should focus on ways of expanding methodology in both written and oral domains to incorporate a graded definition of morphemes to deepen our understanding of the ways morphological awareness supports reading comprehension.

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Appendix A.

Snigged

This task is orally administered. Read the passage to the student. Have them fill in the blank at the end of the sentence with the appropriate pseudoword (pretend word). Record the word in the blank space.

1. This is a person who knows how to snig. He is snigging onto his chair. He did the same thing yesterday. Yesterday he _____.
2. This is a person who knows how to mab along the street. Yesterday he mabbed along the street. Today he does the same thing. What does he do today? Today he _____ along the street.
3. This person is always tiging his head. Today, as he falls to the ground he tigs his head. Yesterday he did the same thing. What did he do yesterday? Yesterday he _____.
4. Be careful said the farmer. You're always clomming on your shoelace. You're about to clom on it now. You _____ yesterday too.
5. Ever since he learned how to do it this man has been seeping his iron bar into a knot. Yesterday he sept it into a knot. Today he will do the same thing. Today he will _____ it into a knot.
6. This is a zug. Now there is another one. There are two of them. There are two _____.
7. This is a nuz. Now there is another one. There are two of them. There are two _____.
8. It was a bazing day. He felt very bazed. He stuck out his hands and shouted with _____.
9. It was night-time and the moon was shining. He danced luggily and smiled with lugginess. He felt very _____.
10. When the sun shines he feels very chowy. He dances chowily and laughs with _____.

Appendix B.

Chickener

1. The boys decided to *unwork* on Tuesday.
2. Mary wants to *ungo* on holiday this year.
3. She was surprised by the *beautiness* of the mountains.
4. He was full of *afraidness* of the sea.
5. After washing her clothes she *rewet* them.
6. He was still tired and wanted to *resleep*.
7. In Sarah's class some of the children are *bookers* and some are not.
8. He works as a *chickener*.
9. He wanted his carpet cleaned and telephoned a *foamer*.
10. In Mary's class everyone is a *shouter*.
11. He wants to *unclimb* the hill as quickly as possible.
12. John looked in the mirror before leaving and thought that he should *uncomb* his hair.
13. Mary told us a story about a *bi-headed* monster.
14. I read about another country where they are so rich that everyone is
bi-carred.