Conceptualizations of Vocabulary Knowledge in Second Language Reading

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ABSTRACT

Reading research has recognized the strong relationship between vocabulary and reading comprehension. However, we are still perplexed by the precise nature of how readers access and retrieve word meanings while reading. We have not reached a consensus on "what it means to know a word" (e.g., Anderson & Nagy, 1991; Nation, 2001) or how to assess vocabulary knowledge. While background knowledge influences our interpretation of word meanings (e.g., Kintsch, 1998; Adams, 1994), it is unclear how many studies have considered its role in second language reading and vocabulary acquisition. This narrative synthesis integrates empirical findings on the issue, investigating how vocabulary has been conceptualized in the field and what relationships have been explored between L2 vocabulary, prior knowledge, and reading comprehension. Vigorous criteria were used to select 15 studies for inclusion in this synthesis. The majority of studies investigated vocabulary size or depth as a direct causal variable of reading comprehension. Conceptualizations of vocabulary depth knowledge include aspects of prior knowledge, but investigations of depth are limited by available assessment tools. Future research will benefit from investigating bidirectional relationships between prior knowledge, reading, and vocabulary learning, and consider more innovative techniques to investigate prior knowledge in vocabulary and reading.
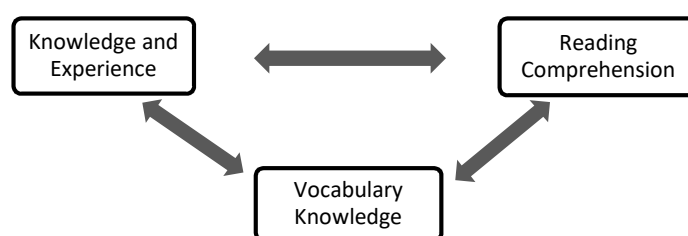
INTRODUCTION

It's widely recognized in both L1 and L2 reading research that vocabulary knowledge makes an important, albeit complex contribution to second language reading comprehension (Grabe, 2008; Koda, 2005). Scholars have expressed different stances about the precise nature of the relationship between vocabulary and reading comprehension, leading to the development of various theories and models (e.g., Anderson & Freebody, 1981; Mezynski, 1983; Nation, 1993). In the instrumental view of vocabulary knowledge, vocabulary is seen as a direct, causal variable of reading comprehension.

This view is often employed in bottom-up models of reading comprehension. However, we can also recognize it as an oversimplification of the reading process. Most researchers agree that successful reading requires not only vocabulary knowledge, but other important knowledge and
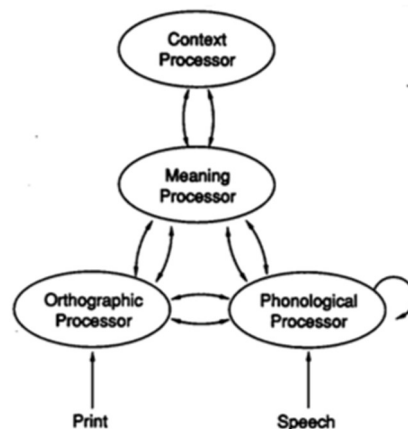
skill areas, ranging from lower-level skills such as phonological decoding, word recognition and syntactic knowledge, to higher-level skills such as activation of prior knowledge, information storage, coherence building and comprehension monitoring.

Anderson and Freebody (1981) described another model, called the "knowledge hypothesis" of reading, which emphasizes that knowing a word well implies that one knows many other words and ideas related to it. This larger "chunk" of knowledge is important for adequate reading comprehension (p. 255). In this model, vocabulary knowledge can be an indicator of not only reading comprehension, but also of general knowledge and experience. In reverse, knowledge and experience is also crucial for reading comprehension. Current models of reading comprehension (Kintsch, 1988; 1998, Adams, 1994) recognize the bidirectional relationships between each of the three variables, which is also considered an "interactive view" of vocabulary knowledge and reading:

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┌──────────────┐                    ┌──────────────┐
│ Knowledge and│◄──────────────────►│   Reading    │
│  Experience  │                    │Comprehension │
└──────────────┘                    └──────────────┘
         ◄─┐                        ┌─►
           └──►┌──────────────┐◄───┘
               │  Vocabulary  │
               │  Knowledge   │
               └──────────────┘
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According to Kintsch's Construction-Integration (CI) model (1988; 1998) model of reading comprehension, when readers approach a text, they first use their linguistic knowledge (e.g., lexical and syntactic knowledge) to construct a textbase. When readers come across different lexical and grammatical forms, visual and semantic memories are instantly activated and the correct meaning is decided upon when the "perceived" meaning is integrated with the reader's prior knowledge. Prior knowledge integration helps readers decide which elements fit together and which do not; elements that do not fit are deactivated. As readers construct a textbase, there are multiple interlinked connections between written word forms, lexical meanings, local text meanings and readers' prior knowledge, which allows them to build a mental representation of the text, referred to by Kintsch (1988; 1998) as the situation model. As with all current models of reading, Kintsch's CI model assumes reader-text interactions at all stages of the reading process.

In Adam's' (1994) interactive model of reading, successful decoding depends on strong connections between spellings, speech sounds, meanings, and context in a four processor system. This system is made up of the orthographic, phonological, meaning, and context processors.

(Adams, 1994, p. 158)

The meaning processor facilitates access to the lexical meaning of words and the more frequently a word is interpreted, the stronger, more focused and faster the connections between orthographic and meaning processors become. Readers' understanding of context helps them activate "relevant components of a words' meaning" and select appropriate interpretations of ambiguous words (p. 175). In addition, context "reinforces the strength, speed and appropriateness in which the system understands a word's meaning," and in doing so, automatically increases the strength, speed and appropriateness of the orthographic and phonological processors (p. 175). As with Kinstch's (1988; 1998) CI model, Adams' reading comprehension model includes both operation level processes and the incorporation of reader-based knowledge sources.

In order to enhance our understanding of vocabulary research in the field of SLA, one of the aims of this narrative synthesis was to investigate how vocabulary knowledge has been conceptualized in light of current models of reading comprehension. To inform this investigation, this paper first considers the history of L1 and L2 reading research, and in what ways previous theories about reading have influenced current conceptualizations of vocabulary knowledge.

The Linguistic Threshold Hypothesis and an Instrumental View of Vocabulary

Several second language researchers have investigated if Chall's (1967, 1983) stages of reading development might apply to second language readers. The well-known "threshold hypothesis" (Cummins, 1979) claims that young L2 readers are not likely to benefit from the cognitive and academic aspects of being bilingual until they reach a certain threshold of linguistic competence in the second language. Alderson (1984) extended this hypothesis, stating that L2 readers cannot transfer L1 reading strategies to their L2 reading until they reach a certain level of linguistic competence in their second language. Similar to Chall's "learning to read" stages of development, the threshold hypothesis assumes that second language learners must gain the basic mechanics of second language reading, such as L2 decoding skills and L2 vocabulary knowledge, before they reach the linguistic threshold where they can "read to learn." Many studies on vocabulary coverage (e.g. Laufer, 1986, 1992) have used vocabulary knowledge as a "proxy" for linguistic competence, investigating the threshold level of vocabulary knowledge needed before "adequate" reading comprehension can be achieved. In doing so, these studies have employed an instrumental view of vocabulary knowledge, concluding that learners require

knowledge of 95-98% of the words in academic texts before adequate comprehension can be reached (Hirsh & Nation, 1992; Hu & Nation, 2000). Although these results have been widely cited and accepted in many research and teaching circles, there is reason to be cautious of how we interpret the numbers. The 95-98% vocabulary coverage estimate is based on assessments that test learners' ability to match a large number of isolated words with appropriate synonyms or short definitions, processes that focus on word-level operations. Missing from this picture is a measure of readers' ability to integrate prior knowledge with the definitions (lexical meanings), and do so in a context-bound environment.

Prior Knowledge and Word Meaning

In a widely cited article, Anderson and Nagy (1991) argue that "the standard model" of vocabulary knowledge is not sufficient to explain what happens in the process of reading comprehension. By "the standard model," they refer to models that conceptualize vocabulary knowledge as generalizations about the set of items or concepts to which a word refers, commonly labeled as "definitions." Anderson and Nagy refer to this as *abstract* core information about a word. *Abstract,* rule-based knowledge is useful because it allows us to apply words to the new items or concepts we encounter. For example, we can identify an Irish setter as a dog, even if we have never seen one before because it is a mammal, has four legs, and other qualities that can be generalized to the category of "dog." Nevertheless, *abstract* knowledge does not comprehensively describe the representations we have when we encounter words in real-life contexts. Anderson and Nagy (1991, p. 5) offer three different situations:

1. Knowledge of a word's meaning is stored exclusively in the form of a rule or generalization and no information about individual examples is stored in the mental lexicon.

2. Knowledge of a word's meaning is stored exclusively in terms of a set of contextualized examples of the use of that word and situations in which these examples are embedded. No rule is stored.

3. Knowledge of a word's meaning is stored both in terms of contextualized examples, and in terms of a rule, perhaps an incomplete one, that helps determine the set of possible uses of the word.

As many second language reading scholars have already noted, research and pedagogical practices have largely conceptualized vocabulary knowledge as word definitions (Situation 1). However, it seems important for us to also investigate and promote Situation 3, where students can produce examples of how a word is used based on world knowledge and contextualized usage of the word.

Some might argue that adult second language learners draw from their L1 experiences to imagine contextualized examples for an L2 word, especially for L2 words that have similar pragmatic functions in their L1. To a certain extent this may be true for concrete nouns and high frequency words. However, learners will encounter many concrete and abstract words in their L2 that do not have direct translations in their L1, are used in a different set of contexts, and have a different variety of meaning senses and connotations. For example, in teaching students about

a target language culture, they will undoubtedly run into L2 words describing abstract cultural concepts, values, practices, and products. Moreover, in learning about the target culture or other content material, learners will require the knowledge of abstract, academic words to comprehend texts and engage in higher order thinking skills for comparing, explaining, classifying, evaluating cultural concepts. This type of vocabulary knowledge extends well beyond memorized definitions.

Koda (2016) emphasizes the central role of prior knowledge in vocabulary acquisition, explaining, "word meanings in a way serve as passcodes to stored knowledge bases," maintaining that "if word meanings only consist of definitions, we must assume that they have a restricted role in linking the words in a text to the reader's prior knowledge" (pp. 6-7). When we read, we extract phonological and morphological information from printed text to retrieve abstract core meanings. Considering Kintsch's (1988; 1998) CI model or Adams' (1994) interactive view of reading, prior knowledge must be integrated with these abstract core meanings in order for us to construct a situation model and achieve reading comprehension. To investigate the merits of current mental models of reading, it is important to consider other facets of vocabulary knowledge. The following section explains conceptualizations of vocabulary size and depth, and discusses the extent to which they address readers' prior knowledge sources.

Vocabulary Size and Depth

In the past thirty years, researchers have broadened their conceptualizations of vocabulary knowledge to include vocabulary size and depth. Vocabulary size is *the number of known words,* while vocabulary depth is often defined as *how well words are known.* Because vocabulary size emphasizes the number of known words, vocabulary size assessments tend to measure how many words that a learner can match with appropriate definitions or synonyms, using a representative sample of words from various frequency bands (e.g., the Vocabulary Levels Test: Nation, 1990, 2001; Schmitt, Schmitt, and Clapham, 2001). Since learners are mainly tested on their knowledge of word-level definitions, vocabulary size tests tend to measure *abstract* knowledge about words, disregarding meanings attributed from readers' prior knowledge. Nevertheless, because vocabulary size tests such as the Vocabulary Levels Test are relatively quick to administer, they are a valuable way to collect a rough estimate of learners' language proficiency.

In the conceptualization of vocabulary depth, Richards (1976), Read (2000), Nation (2001), and Schmitt (2014) have described various other aspects of knowing a word. Nation (2001) provides one of the most comprehensive tables of vocabulary depth, describing nine dimensions of receptive and productive vocabulary knowledge (Table 1).

Table 1. What is Involved in Knowing a Word
(Nation, 2001, p. 27)

Form	spoken	R	What does the word sound like?
		P	How is the word pronounced?
	Written	R	What does the word look like?
		P	How is the word written and spelled?
	word parts	R	What parts are recognizable in this word?
		P	What word parts are needed to express this meaning?
Meaning	form and meaning	R	What meaning does this word form signal?
		P	What word form can be used to express this meaning?
	concept and referents	R	What is included in the concept?
		P	What items can the concept refer to?
	Associations	R	What other words does this make us think of?
		P	What other words could we use instead of this one?
Use	grammatical functions	R	In what patterns does the word occur?
		P	In what patterns must we use this word?
	Collocations	R	What words or types of words occur with this one?
		P	What words or types of words must we use with this one?
	constraints on use (register, frequency . . .)	R	Where, when and how often would we expect to meet this word?
		P	Where, when and how often can we use this word?

It appears that Nation's "concept and referents" dimension of vocabulary depth (Table 1) may require learners to integrate their prior knowledge sources in determining "What is included in this concept?" or "What items can this concept refer to?" Based on this description, it is unclear if the construct of vocabulary depth encompasses reader's prior knowledge and experience with the concept(s) the word signifies.

Many scholars agree that studies on vocabulary depth seem to lack a strong theoretical basis for choosing what they measure (e.g. Li & Kirby, 2014, Schmitt, 2014). In addition, scholars have yet to come to a consensus on the research and assessment value of measuring vocabulary depth (e.g., Vermeer, 2001). If we are interested in the interactions between vocabulary knowledge and reading comprehension, the field should benefit from considering current interactive models of reading comprehension, where conceptualizations of vocabulary depth encompass readers' prior knowledge sources. However, the current state of research may be limited by the types of relationships investigated and the assessments used to measure vocabulary and reading.

In summary, much research to date has investigated an instrumental view of vocabulary on reading comprehension, with little attention to reader's integration of prior knowledge sources. However, the past three decades have witnessed a renewed interest in the conceptualization of vocabulary knowledge, specifically the added value of knowing learners' vocabulary depth in addition to vocabulary size. At this point, it is still unclear how the field of reading and vocabulary acquisition addresses interactive views of reading comprehension, or the role of reader prior knowledge sources in word knowledge. In order to assess the field's current progress in conceptualizations of vocabulary knowledge in second language reading, this narrative synthesis investigates the following research questions:

1. How has the relationship between L2 vocabulary knowledge and reading been conceptualized in the field?
2. How has vocabulary knowledge been conceptualized and measured in the field? What kind of research findings have we been able to attain with these models?

3. To what extent are current conceptualizations of vocabulary knowledge aligned with interactive views of reading comprehension?

METHOD

A systematic search for empirical studies was conducted, investigating the relationship between vocabulary knowledge and reading comprehension. In order to provide answers to the research questions, it was important that studies included both vocabulary knowledge and reading comprehension as two focal points of inquiry, but not to the exclusion of others (e.g., a qualifying study could investigate vocabulary depth, reading comprehension, and another variable such as syntax or morphological awareness). In addition, studies involving children 17 years or younger were excluded because their cognitive development and level of prior knowledge differ enough with adults to potentially become a confounding variable.

The databases used to search for articles were PsychInfo, MLA International Bibliography, Linguistics & Language Behavior Abstracts (LLBA), and the Education Resources Information Center (ERIC). Because "vocabulary knowledge" and "reading comprehension" were often described using different terms in second language literature, the author endeavored to be as comprehensive as possible by including the following key terms in the search: "reading comprehension," "reading proficiency," "reading performance," "text comprehension," "vocabulary knowledge," "word knowledge," "word meaning," "lexical knowledge," "lexical competence," "vocabulary breadth," "vocabulary depth," and "vocabulary size," "second language" OR "L2." Boolean algorhitms were used so that any combination of a "vocabulary knowledge" term, "reading comprehension" term, and "second language" term were searched for within journal article abstracts.

Using these selected key terms, the first search resulted in 307 hits. Studies fit the inclusion criteria if they were:

(1) Empirical studies with primary data
(2) Focused on adult second language learners
(3) Included both vocabulary knowledge and reading as two focal points of the empirical investigation

The following exclusion criteria were then applied:

(1) Studies could not limit their focus on vocabulary knowledge to specific categories of words such as cognates or kanji character compounds
(2) Studies could not be focused on disabled or impaired individuals
(3) Studies were not focused on pedagogical interventions of vocabulary learning
(4) No dissertations were included in the synthesis

Pedagogical interventions were excluded because this investigation did not intend to compare "best methods" for vocabulary learning and teaching. In addition, dissertations were excluded because they are usually not subject to the same vigorous peer review processes as articles in peer-reviewed journals. Based on these criteria, the 107 articles were identified for possible selection. The titles and abstracts were read through and 38 studies were identified for possible inclusion in the synthesis. Each article was then retrieved and scanned for further scrutiny until a

total of 15 studies were selected as suitable for inclusion in the synthesis. These studies are organized in Appendix A, based on the focal measures used to investigate vocabulary: studies on vocabulary size and lexical coverage, vocabulary depth, and lexical inferencing.

RESULTS AND DISCUSSION

Overview of Participants

Overall, this synthesis included eleven studies on English language learners (with various L1 backgrounds), two on L1 English learners of L2 Spanish, one study on L1 English learners of L2 Arabic, and one study on L1 Chinese and L1 Korean learners of L2 Japanese. All studies involved adult participants in pre-university, university, and graduate programs; no studies included adult learners outside higher education contexts. For this reason, we may be cautious when interpreting results, as the included research only represents middle-class educated populations. While thirteen of the fifteen studies focused on intermediate or advanced language learners, two studies by Pulido (2007, 2009) looked at various proficiency levels, including beginner, intermediate, and advanced learners.

Research Question 1: How has the relationship between L2 vocabulary knowledge and reading been conceptualized in the field?

In total, thirteen of the fifteen studies included in this synthesis specifically investigated the contribution of vocabulary knowledge to reading comprehension. Half of the studies examined the role of syntactic knowledge in addition to vocabulary knowledge, and several studies also investigated other variables such as metacognitive awareness, topic familiarity, and general academic knowledge. Overall trends are consistent with prior literature, indicating that vocabulary knowledge makes a significant contribution to reading comprehension.

There were only two studies that investigated the opposite cause-effect relationship: how reading ability influences learners' ability to learn and infer new vocabulary words. Both studies were conducted by Pulido (2007, 2009), who examined the influence of L2 reading ability and topic familiarity on reading comprehension. In both studies, reading comprehension and topic familiarity were found to have positive significant effects on the receptive retention of inferred vocabulary words.

The first aim of this synthesis was to obtain a representative sample of studies reflecting the current state of vocabulary acquisition research in adult second language reading literature. Based on the results, it appears that the conceptualization of vocabulary as a direct causal factor of reading comprehension has dominated this area of L2 research for the past thirty years. This trend is in line with the hypothesis proposed in this study, which predicted that influences from theoretical orientations such as the linguistic threshold hypothesis and findings from vocabulary coverage research (e.g. Hu & Nation, 2000) have heavily influenced the way the relationship between reading and vocabulary knowledge has been explored in the field. It is also possible that little attention has been given to reading proficiency's role in vocabulary learning because it is both difficult to measure incidental vocabulary learning, ideally requiring longitudinal research. While studies investigating the role of vocabulary knowledge in reading comprehension have continued to confirm the strong relationship between these two variables, we still lack any strong basis for claiming vocabulary knowledge as a causal variable. Since most reading scholars agree that word-level reading subskills have reciprocal relationships with

text-level comprehension subskills, it seems evident that the reverse role of reading comprehension's influence on vocabulary knowledge also deserves more attention.

Research Question 2: How has vocabulary knowledge been conceptualized and measured in the field? What kind of research findings have we been able to attain with these models?

Within the thirteen studies investigating a direct causal model, six conceptualized vocabulary knowledge as "vocabulary size" or "lexical coverage," defining vocabulary knowledge as *the number of words* known (Table 1). The other seven studies investigated "vocabulary depth," in addition to size, in order to measure *how well* words were known (Table 1). Because vocabulary depth involves at least nine dimensions of vocabulary knowledge (Nation, 2001), various assessments have been designed to investigate different aspects of vocabulary depth. The next two sections explain the types of assessments used to measure vocabulary size or lexical coverage and vocabulary depth.

Vocabulary Size and Coverage studies
These studies measured learners' vocabulary size (the total number of words known), lexical coverage (the percentage of words known in a reading passage), or a combination of both. The most common instrument used for measuring vocabulary size was the Vocabulary Levels Test (VLT), which requires learners to match vocabulary words in a given sentence with the synonym that is closest in meaning. There are five sections to each test, each one testing a different frequency band of vocabulary items: the 2,000 word level, the 3,000 word level, the 5,000 word level, university word level, and the 10,000 word level.

Figure 1. Example Problem from The Vocabulary Levels Test (Nation, 1983)

This is a vocabulary test. You must choose the right word to go with each meaning. Write the number of that word next to its meaning. Here is an example.

1 business	_____ part of a house
2 clock	_____animal with four legs
3 horse	_____ something used for writing
4 pencil	
5 shoe	
6 wall	

Another common measure of vocabulary size was "lexical coverage." In order to measure lexical coverage, two studies (Schmitt et al., 2011; Laufer & Ravenhorst-Kalovski, 2010) estimated the percentage of words learners know in a passage by using a vocabulary profiler to analyze reading comprehension passages for the number of vocabulary words from word families in different frequency bands based on the British National Corpus. With this information, researchers used learners' vocabulary sizes from the VLT to estimate the percentage of words known in a passage. The only other type of vocabulary size measurement used was in Khaldieh's (2001) study, in which participants were asked to supply L1 translations or L2 synonyms for 22 target words in a reading passage. Overall, vocabulary size tasks all measured learners' ability to match or provide L2 synonyms, short definitions, or L1 translations to target words.

All studies found vocabulary size to be the strongest predictor of reading comprehension except one. Only two studies investigated other reading skills in addition to vocabulary size, but of these, Shiotsu and Weir (2007) found syntactic knowledge to be a stronger predictor of reading comprehension than vocabulary. Specifically, they found that syntactic knowledge contributed 4-10% more variance to reading comprehension than vocabulary knowledge in all three studies included in their article. Some have argued, however, that Shiotsu & Weir's syntactic knowledge assessment may be confounded with vocabulary knowledge because it required learners to have high levels of vocabulary in order to understand the sentence items and decide which types of grammatical forms were appropriate (Zhang & Koda, 2011). Shiotsu and Weir also acknowledged that vocabulary and syntactic knowledge are difficult to separate in assessment. The accumulated results indicate that vocabulary size and coverage are the strongest predictors of reading comprehension.

In summary, all six vocabulary size and lexical coverage studies conceptualized vocabulary knowledge as learners' ability to match L2 definitions, L2 synonyms, or L1 translations with target words and all six studies found moderate to strong significant relationships between vocabulary knowledge and reading comprehension. These results further support that the receptive knowledge of word definitions, synonyms, and L1 translations is strongly related to reading comprehension. However, the reason for this strong correlation remains unclear, as we cannot claim causality. For instance, a learner with high receptive vocabulary knowledge of isolated word definitions may simply be a result of having a strong linguistic proficiency. As Anderson and Nagy (1991) have noted, the "standard model" of word knowledge as *abstract* knowledge or word definitions severely restricts our understanding of how readers comprehend words within connected text. Importantly, studies from L1 research suggest that improving readers' isolated word knowledge alone is not sufficient enough to improve reading comprehension (Pany & Jenkins, 1978; Pany, Jenkins, & Schreck, 1982). Likewise, evidence from L2 text glossing studies also show that access to L2 word definitions alone do not necessarily result in higher reading comprehension scores (Jacobs, Dufon, and Fong, 1994). This evidence suggests that knowledge of word definitions is not sufficient for reading comprehension, and that vocabulary size tests are a better indicator of L2 language proficiency rather than the specific skills needed to comprehend texts. Because the field has started recognize the limitation of vocabulary size tests, it is not surprising that many of the synthesized studies also include measures of vocabulary depth, as discussed in the next section.

Vocabulary Size and Depth

A total of seven studies conceptualized vocabulary knowledge as complex, indicating that both vocabulary size and depth are important components of vocabulary knowledge. Many referred to vocabulary depth as the knowledge of how a word's meaning changes in different contexts. In order to understand how word meanings change in context, most researchers agreed that learners require various dimensions of vocabulary knowledge, such as frequency, register, syntax, derivation, association, semantic features, and polysemy, dimensions included in Nation's (1990; 2001) and Richards (1976) descriptions of what it means to know a word. As a result, six of the seven of the studies utilized Read's (1993, 1998) Word Association Task (WAT) or Qian's (1998, 1999; Qian & Schedl, 2004) Depth of Vocabulary Knowledge (DVK) test, which are vocabulary assessments designed to measure learners' knowledge of word associations, collocations, synonyms, and polysemic words. In the WAT and DVK, participants are shown a target word with eight words below, organized in two boxes. Learners must choose one to three

words can be synonymous to the stimulus word from the four words from the left box, and choose one to three words that can collocate with the stimulus word from the right box.

Figure 2. Example of DVK item (Qian, 2002)

sound

logical healthy bold solid	snow temperature sleep dance

Of the six studies that measured vocabulary size in addition to depth, all used a version of the Vocabulary Levels Test (Nation, 1983; 1990; Schmitt et al., 2011). All of these measures have gained popularity for their high reliability and ease of administration. Zhang and Koda's (2011) study is notable because it looked not only at vocabulary size and depth, but also at the direct and indirect effects of morphological awareness and lexical inferencing on vocabulary knowledge and reading comprehension. Their tasks measured learners' ability to identify derivate roots of multimorphemic words or make predictions about the meaning of unknown words based on intra-word morphological clues. This is the only study in the synthesis that included a task to measure the "word parts" (Table 1; Nation, 2001) dimension of vocabulary knowledge.

Only one study by Nergis (2013) did not find vocabulary knowledge to be significantly related to reading comprehension, but did find significant relationships between syntactic knowledge and metacognitive awareness. While this result is inconsistent with other literature, Nergis suggested that the participants in his study were extremely advanced ESL learners studying to become English language educators. It may be that for learners with strong linguistic skills, metacognitive strategies are the largest contributor to successful reading, but we cannot form solid explanations about this result without more studies addressing these reading subskills.

Of the six studies that measure both vocabulary size and depth's contribution to reading comprehension, all found that one measure of vocabulary explains a small amount, if any variance beyond the other. Three of these studies conducted a multiple regression analysis to compare size and depth. Qian (2002; 2004) found that vocabulary size and depth are highly related, but that depth explained a small amount of unique variance in reading comprehension beyond size (from 4 to 14%). Horiba (2012) also found that vocabulary depth (collocational knowledge) could explain 4% of the variance beyond vocabulary size for L1 Chinese learners of L2 Japanese, but only vocabulary size significantly predicted reading comprehension for L1 Korean learners.

Three studies investigated specific dimensions of L2 vocabulary depth and size knowledge together using structural equation modeling (SEM). These types of analyses provide some advantages over regression analyses because SEM can include more than one dependent variable, direct and indirect effects of variables, and accounts for measurement error. Zhang and Koda (2011) found that morphological awareness, vocabulary size, vocabulary depth, and lexical inferencing together explained about 22.1% of the variance of reading comprehension, but no single variable had any significant unique or direct effect on reading comprehension after adjusting for the other variables. In Guo and Roehrig's (2011) and Zhang's (2012) studies, vocabulary depth and size loaded on the same latent variables of linguistic knowledge and vocabulary knowledge, indicating that size and depth were not separable for their particular investigations.

To summarize, the accumulated research on size and depth indicate that vocabulary depth explains little or no variance in reading comprehension beyond vocabulary size. In addition, all

bivariate correlations between size and depth tests were both significant and large (r > 0.6). As mentioned in the introduction, other studies of vocabulary size and depth studies have noted similar trends (for an overview see Schmitt, 2014). Of course, it may be difficult to see differences in learners' size and depth scores because this type of knowledge usually develops together, as described in the knowledge hypothesis of reading and vocabulary development (Anderson & Freebody, 1981). Also, it is clear from the strong bivariate correlations between vocabulary size and depth that they are overlapping constructs. We have yet to determine whether or not vocabulary depth provides us with valuable data beyond variance explained by vocabulary size, and a strong theoretical explanation for why we should pay attention to it.

In regards to assessment, vocabulary depth has been primarily measured using the WAT and DVK tests. These tests require learners to have abstract semantic core knowledge of not only the target word items, but also of each possible collocation, synonym, and word association answer (Figure 2). If learners need knowledge of all items and possible answers, then we should not be surprised by the high correlations between vocabulary depth and size tests. This prompts the question, is vocabulary depth a useful way to conceptualize vocabulary knowledge? As Read (2004) mentions, one solution is to revise our understanding of "vocabulary depth" as a single, measurable construct, and instead choose specific dimensions of vocabulary to investigate based on more refined, specific research questions. Rather than treating vocabulary depth as an "all-encompassing" measure of learners' vocabulary knowledge, it may be more conducive to study how specific dimensions of vocabulary are differentially related to specific aspects of reading. However, the field will make stronger advances if the formation of more specific research questions are be driven by theoretical models of reading and reader-word interaction, particularly taking into account the contextual and functional use of words in connected text.

We may note here that current assessments of vocabulary depth have not yet addressed word knowledge stemming from learners' prior knowledge and experiences, described by Nagy and Anderson (1991). The synonyms, collocations, polysemy, and word association knowledge that current depth tests measure all fall under the umbrella of *abstract* knowledge, because they are simply different labels for word forms that also employ rule-based approaches to making generalizations about the concepts to which a word refers. As described by Anderson and Nagy (1991), this type of knowledge is not supplemented with knowledge of real-life experiences or contexts in which the words are used. Readers may be able to build a textbase with knowledge of synonyms, polysemy, collocations, and word associations, but without integrating their prior knowledge sources, readers cannot create a situation model (Kintsch, 1988; 1998) or reinforce the links between printed words, sounds, lexical meanings, and context.

Vocabulary knowledge as Lexical Inferencing

There were only two studies (Pulido, 2007; Pulido, 2009) that investigated the influence of topic familiarity and reading comprehension level on vocabulary learning. Pulido was explicit in defining her conceptualization of vocabulary knowledge, which guided her choice of instruments. She describes vocabulary development through reading as "associating new forms with their functions or referents" (2007, p. 32) and "comprehending a new lexical item entails assigning meaning to it, thus establishing a new form-meaning connection" (2009, p. 156). Because she draws heavily on the involvement of the load hypothesis (Laufer & Hulstijn, 2001), her vocabulary intake and retention measures were aligned with her research questions.

In both her studies, Pulido considered the effect of L2 reading ability and topic familiarity on vocabulary learning. After confirming that learners had similar familiarity or

unfamilarity with two reading passages, participants read the two passages with eight target pseudowords each. They had to infer the meanings of these target words from the passage context. Pulido measured vocabulary learning and retention through various memory tasks. The first task was a word form recognition task in which participants had to indicate whether or not they had seen a target pseudoword before from the passages they had read. The second was a multiple choice receptive and productive translation test in which learners were asked to provide an L1 translation or L2 synonym of the target pseudowords. In her 2007 study, Pulido also included a delayed retention of meaning task 28 days after learners read the comprehension passages. She used these measures to explore links between lexical item forms and meaning after controlling for background knowledge. In both studies, she found that L2 reading proficiency and topic familiarity led to larger significant gains in vocabulary learning.

We may note that Pulido's vocabulary measurements also required learners to produce L1 translations or L2 synonyms. The tasks measure learners' ability to make productive and receptive links between newly encountered word forms and *abstract* knowledge, based on word translations or definitions generalizable to any context. Therefore, Pulido's focus was on learners' ability to both infer words and retain abstract knowledge about the words in memory. While it is possible that learners were also able to retain memory of the contexts where the target words were used from the original passages, this type of knowledge was not o in observed Pulido's studies.

In summary, only two studies have investigated readers' ability to retrieve vocabulary meanings through reading. Pulido takes into account the importance of prior domain knowledge in reading comprehension by considering the effect of topic familiarity, passage comprehension and reading proficiency on the ability to produce and recognize abstract definitions of newly encountered words. However, in order to look at the interaction between learners' prior knowledge and word acquisition, we would need a way to observe the how learners' assign meanings to words as they fill in semantic gaps in their developing situation model, or mental representations of a text.

Research Question 3: To what extent are current conceptualizations of vocabulary knowledge aligned with interactive views of reading comprehension?

Both Kintsch's construction integration model (1988; 1998) and Adams' interactive model (1994) of reading comprehension treat vocabulary as one part of an integrated, multiple component process. Kintsch's model places importance on both linguistic knowledge and prior knowledge held in long-term memory. Access to basic word meanings (e.g., definitions) helps learners build a textbase, but readers' integration of prior knowledge with lexical meanings constrains the way discourse representations are constructed. In Adams' model, the meaning processor contains our knowledge of word meanings, and the context processor is in charge of constructing a coherent, on-going representation of the text. This is important for selecting meanings that are appropriate for the context and is important not only for the interpretation of ambiguous words, but to a lesser extent for all words. Both models see vocabulary and world knowledge as inseparable. In addition, vocabulary and world knowledge are seen to have a bidirectional relationship with reading and with each other.

As mentioned, six studies in this synthesis investigated the influence of vocabulary size alone on reading comprehension. Two of these studies, however, did not explicitly state how they conceptualized vocabulary and the theoretical basis for the measures used to assess

vocabulary knowledge. Instead, it appears that these studies assumed a "standard model" of vocabulary knowledge, in which word knowledge is equated with knowledge of abstract core semantic meanings. Hence, all six studies associated vocabulary knowledge with L2 definitions, synonyms, or L1 translations of the target word. This type of knowledge shows learners' ability to associate one lexical meaning with another, but not necessarily their ability to link lexical meanings with prior knowledge and create mental representations. In Kintsch's model, it is possible that vocabulary size tests can provide a good predictor of reader's ability to create form-meaning links and construct a textbase, but the prior knowledge required to connect word meanings with prior knowledge to create a situation model may require other types of measures.

Seven studies looked at different dimensions of vocabulary depth and four of these explicitly conceptualized vocabulary as "size" and "depth." Several of the studies measured learners' knowledge of collocations, grammatical functions, and word parts (morphological awareness) using a morphological awareness task or the WAT or DVK. If we refer back to Nation's (2001) description of what is involved in knowing a word, these dimensions of knowing a word fall under the "form" and "use" categories, as they provide learners with knowledge of the linguistic rules needed to start building a textbase and generating propositions. On the other hand, word associations, synonyms, and polysemy would probably fall under Nation's (2001) category of "meaning," or specifically: "What other words does this make us think of?", "What other words can we use instead of this one?" and "What meaning does this word form signal?" (Table 1). Knowledge of word associations and synonyms may indicate the strength of readers' form-meaning and form-form links, which also helps predict readers' ability to build a textbase. However, even if readers are able to correctly identify word associations, they run into the same dilemma as vocabulary size measurements; readers are not necessarily able to attach abstract core meanings of word associations to prior knowledge or contextualized mental representations. We have yet to see vocabulary depth tests that consider the meanings of words attributed from the readers themselves (Anderson & Nagy 1991), which either requires context or multiple encounters with the word (individually generated rules abstracted from experience).

Finally, only two studies investigated how the context or world knowledge and reading comprehension level influence vocabulary learning. Pulido's (2007; 2009) decision to use familiar and unfamiliar texts has been one method to investigate the influence of world knowledge on reading comprehension, but it is still unclear whether learners were able to link their prior knowledge of familiar texts with lexical meanings in the passage. Unfortunately, we do not have enough research to understand the connections between topic familiarity, incidental vocabulary learning, and reading comprehension. As mentioned previously, Pulido measured vocabulary learning as learners' ability to infer target word definitions from passages and retain them in memory. Although she investigated a "top-down" relationship between reading and vocabulary knowledge, her tests of vocabulary knowledge measured learners' ability to supply L1 translations or L2 synonyms, similar to the VLT. While future research should continue to address the relationships between reading comprehension level, topic background knowledge and vocabulary development, it should consider how learners' assign and reassign meanings to words as they fill in semantic gaps in their developing situation model, or contextualized mental representations of a text.

CONCLUSION

The aim of this synthesis was to map out how vocabulary knowledge has been conceptualized in second language reading literature, review its role in current models of reading comprehension, and determine important areas of vocabulary research that still need to be addressed. Thirteen of the studies investigated the influence of vocabulary knowledge on reading comprehension, conceptualizing vocabulary in terms of size and/or depth. The other two studies investigated the influence of reading on vocabulary learning, specifically focusing on learners' ability to lexically infer and retain words from the text. All studies employed vocabulary instruments that measure learners' knowledge of word definitions, L2 synonyms, or L1 translations through the VLT or a receptive or productive L1 translation tasks. These studies have been able to (1) reconfirm that there is a strong correlation between vocabulary size and reading comprehension and (2) provide a small amount of evidence that reading proficiency improves learners' ability to retain vocabulary definitions in memory.

Limitations

Because vocabulary and reading are terms used pervasively in second language literature, various criteria were used to narrow the search; however, in doing so it is possible that several studies relevant to this synthesis's research questions may have been excluded. The search was limited to keywords found in the title and abstracts, and the abstract had to indicate that the study focused on both vocabulary and reading as focal constructs, rather than just one alone. To counteract this potential limitation, a large variety of search terms were used in combination with Boolean algorithms in order to be as comprehensive as possible. Because this produced a tremendous number of hits, and a substantial amount of time was spend reading titles, abstracts, and skimming articles to identify studies that fit the inclusion and exclusion criteria. Despite these careful efforts, it is still possible that relevant studies were missed in this process.

This investigation is labeled as a "narrative synthesis" or "scoping review" due limitations of available research. While meta-analyses are ideal for summarizing accumulated literature from quantitative studies, they can only be performed when there are enough empirical studies using comparable methods, participants, and contexts to compare effect sizes or relationships between the same constructs. This synthesis used rigorous selection criteria to identify 15 studies for inclusion, and these studies used different ways of defining and measuring vocabulary knowledge and reading among a diverse group of participants and contexts. Given the differences among this small number of studies, this synthesis was limited to looking at trends in the data rather than using inferential statistics to compare effect sizes. However, the findings should help inform future empirical inquiries into relationships between vocabulary, reading skills, and the role of prior knowledge.

Future research

None of the studies in this synthesis investigated two-way reader-text interactions and the role of prior knowledge in vocabulary knowledge acquisition. Vocabulary knowledge was investigated as a direct casual variable of reading comprehension in the majority of studies, while vocabulary acquisition as a result of reading proficiency was studied in two of the fifteen studies. Reading research may benefit from more investigations of the reciprocal relationship between vocabulary and reading, or from more research on the development of vocabulary knowledge through reading.

It also appears that for practical research and pedagogical reasons, the standard model of conceptualizing word knowledge as abstract core meanings (definitions and translations) has become both a default and an accepted way to measure learners' vocabulary knowledge and make claims about its role in reading comprehension. Nevertheless, if we want to investigate interactive models of reading comprehension, future research can consider reader-word interactions in the conceptualization of vocabulary knowledge; namely, the meanings attributed to words based on context and individuals' prior experiences. These dimensions of knowing a word have not yet been addressed in studies of vocabulary depth.

While we have established that knowledge of a large number of abstract core meanings is important for general reading comprehension, readers may learn words differently and use different word learning strategies based on their reading purpose. As Grabe and Jiang (2013) have noted, standardized and classroom reading assessments are starting to incorporate reading for other purposes, such as "reading to learn" or "reading to evaluate." If we consider performance-based usage of vocabulary knowledge in academic and professional contexts, then it is worth investigating how learners use "words as tools" (Nagy & Townsend, 2012) to retrieve meanings, refine stored knowledge of words in relation to prior knowledge, and use words to communicate newly learned information to others. Given these gaps in the current research base of vocabulary and reading research, some questions that deserve more attention include:

1. What do skilled readers do when they encounter new words or words in unfamiliar contexts? Do skilled readers focus on specific dimensions of vocabulary knowledge more than others while reading?
2. How does the purpose of reading influence vocabulary learning processes and behavior?
3. What types of prior knowledge sources are used to learn new words while reading, and to what extent are they successful?

It is clear that reader-text interactions on the word level are difficult to investigate because it is unrealistic to holistically "measure" prior knowledge. However, methodologically innovative techniques for investigating reader-word interactions are continuing to grow with the advent of various technologies, including eye-tracking software, technology-enhanced learning tools, and various forms of digital media. Our challenge as a field will be to identify and adapt new technologies and methods to investigate the reciprocal nature of vocabulary acquisition and reading, the role of prior knowledge, and reading for different purposes.

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APPENDIX A. Studies included in Synthesis

Vocabulary Size and Lexical Coverage Studies

In-text Citation	Participants	Relationship investigated	How vocabulary knowledge is conceptualized	Vocabulary measurements	Reading comprehension measurements	Analysis/Results
Khaldieh, 2001	46 L1 English university students who are upper-intermediate learners of Arabic	Syntactic Knowledge/ VK → RC	Not explicitly stated	**VS:** Participants were asked to supply L1 **Translations or L2 Synonyms** under each word in reading passage. Twenty-two items were included in Lexical Knowledge score.	**Immediate Recall** in L1 of a 331 word narrative text in Arabic- scored using Bernhardt's (1991) weighted scoring system of pausal units	In a stepwise multiple regression analysis, syntactic knowledge of the Arabic Iʿraab did not show significant effects on reading comprehension (β = -.009, p = .981)), but lexical knowledge (β = 3.78, p < .001) had a strong significant effect on reading comprehension.
Khodadady, 2000	123 native speakers of English and 64 nonnative speaker university students in Australia. NNSs had various L1 backgrounds and areas of study.	Syntactic Knowledge/ VK → RC	VS LC (Lexical coverage)	**VS:** Global vocabulary multiple choice item test (MCIT)- match vocabulary items with a synonym **LC:** Contextual vocabulary MCIT- commonly unknown words from reading comprehension passage were provided in sentences. Learners match target words with correct synonym.	**Reading subtest of TOEFL**- asks about main ideas, supporting ideas, facts from the text, inferences based on passage information, to synthesize information, author tone, attitude	For ELLs, lexical coverage (called "contextual vocabulary knowledge") had a slightly higher correlation with RC (r = 0.45, p < .0001) than vocabulary size (r = 0.44, p < .0001). Syntactic knowledge also had a significant correlation with RC (r = 0.33, p < .01). In a step-wise regression, lexical coverage was the best predictor of RC, accounting for 20% of the variance. Vocabulary size and syntactic knowledge made no further contributions.
Laufer, 1992	46 L1 Hebrew and 18 L1 Arabic university students in Israel, who are advanced EFL learners	VK/General academic ability →RC	VS	**VLT** (Nation, 1983)	**Psychometric entrance exam-** English section with 50 MCQs on the understanding of words, sentence structure, factual information, global comprehension, and inference	Multiple regression indicated that VS contributed 26% to RC and general academic ability (GAA) contributed 16%. However, a further analysis showed if VS is less than 3,000 word families, then RC is not satisfactory and GAA has no influence on RC. If VS is between 3,000 and 4,000 word families, RC was sometimes satisfactory and sometimes exhibited a correlation with GAA. If VS is about 5,000 word families, RC is satisfactory and GAA makes no difference. "Satisfactory" RC scores were not explicitly defined.
	745 L1 Hebrew, Arabic, and Russian		VS	**VS:** VLT (Schmidt, Schmit & Clapham, 2001)	**University Psychometic entrance exam-** 6 texts with 60	Comparing all learners' vocablary sizes, the lexical coverage of passages, and reading test

					MCQs about word items, sentence structure, global textual information	scores in a graph, vocabulary size and RC scores increased linearly until the 6K frequency range; beyond this, RC scores leveled off and learners averaged 96.1% coverage of texts.
Laufer and Ravenhorst-Kalovski, 2010	university students studying (advanced level?) English	VK (lexical threshold) → RC	LC	**LC:** 6 texts from the RC test were analyzed by a lexical profile and Lextutor online text mining tool.		
Schmitt et al., 2011	661 Participants from various countries who are intermediate to advanced learners of EFL. Learners reside in their respective countries	VK → RC, background knowledge → (VK→ RC)	VS LC VD (not measured for sake of practicality)	**LC:** Yes/no checklist, similar to Meara (1992), containing words from the 2 RC passages. Words were selected based on frequency analysis using Lextutor (www.lextutor.ca)	**Multiple choice question (MCQ) tests:** one passage on climate change (familiar) and one passage on exercise and mental acuity (unfamiliar). Each had 14 MCQs that require inferencing skills. **Graphic organizer "information transfer task"**: requires readers to recognize organizational pattern of the text and see clear, logical relationships	The relationship between VS and RC appeared linear from 90 to 100% coverage. Participants with 94-100% vocabulary coverage scored higher on RC, but those in the 90-93% range scored similarly on both familiar and unfamiliar texts. Participants gained higher average RC scores on the text with higher topic familiarity.
Shiotsu & Wier, 2007	Study 1: 107 university students of EAP in the U.K with various L1s Study 2: 182 L1 Japanese EFL learners Study 3: 624 L1 Japanese EFL learners	VS/Syntactic Knowledge → RC	Not explicitly stated; "Knowledge of Vocabulary"	Study 1: **semantic gap-filling test** with answer bank Study 2 and 3: **VLT** (Schmitt et al., 2001)	Study 1: **Text Reading Comprehension**- 4 passages with short answers, table/flow charts, sentence completion Study 2 and 3: **College English Test**- 4 passages with 5 MCQs requiring synthesis of information across sentences	All Studies: SEM analysis indicated that syntactic knowledge was a significant and stronger predictor of reading comprehension than vocabulary knowledge. Study 3 (Main Study): In an SEM analysis, syntactic knowledge contributed to 72% of RC and vocabulary explained 62% of RC. Jointly, they explained 74% of RC.

Note. The following abbreviations are used: Vocabulary Size (VS), Vocabulary Depth (VD), Lexical Inferencing (LexI), Reading Comprehension (RC), Vocabulary Knowledge (VK), Word Association Test (WAT), Vocabulary Levels Test (VLT), Lexical Inferencing (LexI)

Vocabulary Depth Studies

In-text Citation	Participants	Relationship investigated	How vocabulary knowledge is conceptualized	Vocabulary measurements	Reading comprehension measurements	Analysis/Results
Guo & Roehrig, 2011	278 L1 Chinese EFL undergraduates majoring in English Education	VK, Syntactic awareness, Metacognitive awareness → RC	VS (Vocabulary size) VD (Vocabulary depth)	**VS:** Vocabulary Levels Test (VLT; Nation, 1990) **VD:** Depth of Vocabulary Knowledge (DVK; Qian & Schedl, 2004)	**TOEFL-RBC (reading for basic comprehension)**: contained 5 passages and 30 multiple-choice questions (MCQs) on general academic matters. Gray Silent Reading Test Third Edition- 13 developmentally sequenced reading passages with 5 MCQs.	Linguistic knowledge (vocab/syntactic knowledge) and metacognitive awareness explained 87% of the variance in reading comprehension in a 2-factor SEM analysis. L2 linguistic knowledge made a unique contribution to RC, but metacognitive awareness did not.

Horiba, 2012	50 L1 Chinese and 20 L1 Korean university students in Japan, who are intermediate-advanced learners of Japanese	VK → RC	VS VD	**VS:** Japanese version of VLT, based on Nation (1990, 2001) **VD:** Word Association Task (WAT) (Japanese version based on Read, 1993): measured "syntagmatic" (collocational) "paradigmatic" (synonyms and word associations) and "analytic" (key parts of word definition) knowledge	**Written recall** and **Summary completion** of 2 expository texts. Summary completion required filling in blanks of five sentences by selecting from 5 possible answers (MCQs).	For both Chinese and Korean L2 Japanese learners, VS significantly correlated with text comprehension (Chinese: r = 0.45, p < .001, Korean learners: r = .60, p < .01). For L1 Chinese, collocational word knowledge had a reliable moderate correlation with text comprehension (r = .49, p < .001) while word association/synonym and definition knowledge did not. For Korean learners, synonym and word associations (r = .50, p < .05) and definition knowledge (r = .46, p < .05) were moderately correlated with text comprehension.
Nergis, 2013	45 L1 Turkish advanced learners of EFL in the English Language Teaching Department	Metacognitive strategies, syntactic awareness, and VK → RC	VD	**VD:** (DVK; Qian, 1998, 1999) measures synonymy, polysemy, and collocations	**TOEFL-RBC 2000-** Reading for Basic Comprehension (RBC) has 5 passages with 50 MCQs	Using step-wise multiple regression, depth of vocabulary knowledge was *not* found to be significantly correlated with RC, nor was syntactic awareness. Only metacognitive awareness was a significant predictor of RC. The authors suggest this result may have been due to learners' high English proficiency.
Qian, 2002	217 Participants from various countries in Canada who are university and graduate students learning intermediate+ ESL.	VK → RC	VS VD	**VD:** Dept of Vocabulary Knowledge (**DVK**; Qian, 1998, 1999) measures synonymy, polysemy, and collocations **VLT** (Nation, 1983), TOEFL (pre1995) vocabulary subtest measures synonyms or close in meaning word, stimulus words provided in a sentence.	**TOEFL reading comprehension subtest** with MCQs, Did not report information about what these questions tested	VS and VD were very highly correlated at .70. Multiple regression showed that VD contributed 13 and 14% unique variance when entered after VLT or the TOEFL vocabulary section.
Qian & Schedl, 2004	207 Participants from various countries in Canada, who are pre-university, university, and graduate students learning intermediate+ ESL.	VK → RC	VS VD	**Pre-1995 TOEFL Vocabulary section** measure VD: (developed DVK in this study) and modified TOEFL Vocab section to DVK format	**TOEFL Reading for Basic Comprehension** test with 38 MCQs, later analyzed for 5 different types of questions: inference, factual details, main idea, reference, organization & logic	VS and VD were highly correlated at r = .84 (p < .01) and had equivalent relationships to RC. Both VS and VD measures correlated highest with RC questions related to factual details and lowest with RC questions requiring inferences.
Zhang & Koda, 2011	130 L1 Chinese masters students of engineering, who are advanced readers of EFL	Morphological Awareness → Intraword LexI → VK/RC	Morphological awareness aids lexical inferencing, and therefore vocabulary development directly or indirectly.	**MA:** Morphological awareness: derivative root identification task **LexI:** for the lexical inferencing test learners inferred meaning of morphologically complex words based on intra-word morphological clues **VS** (VLT;	**Semantic gap-filling test:** 6 passages with 5 MCQs each, requiring participant to fill in blanks with conjunctions (transition/ linking words), co-references (identifying the antecedent), and textual inferences (linking b/t diff parts of text)	In an SEM analysis, MA and LexI made significant independent contribution to vocabulary knowledge (both size and depth), explaining 34% of the variance. MA, LexI, and VK together explained about 22.1% of the variance of reading comprehension. MA had significant indirect effects on RC through the mediation of VK.

				Schmitt et al., 2001)**VD** (WAT; Read, 1993)		
Zhang, 2012	190 Chinese masters students of engineering in China who are advanced learners of EFL	VK/Grammar→RC	Both VS and VD may contribute to RC	**VD (WAT; Read, 1993, 1998)** **VS (VLT; Schmitt et al., 2001)**	**Multiple choice questions:** 6 passages with 3 MCQ each, requiring co-references (Identifying antecedents), textual inferences (link two parts of the text), and gist (main ideas)	In an SEM analysis, VK and grammatical knowledge contributed 81% of the variance in learners' RC. VK was predictive of RC after accounting for grammatical knowledge (β = .423, p = .036), but grammatical knowledge was not independently predictive of RC after accounting for VK.

Note. The following abbreviations are used: Vocabulary Size (VS), Vocabulary Depth (VD), Lexical Inferencing (LexI), Reading Comprehension (RC), Vocabulary Knowledge (VK), Word Association Test (WAT), Vocabulary Levels Test (VLT), Lexical Inferencing (LexI)

Lexical Inferencing Studies

In-text Citation	Participants	Relationship investigated	How vocabulary knowledge is conceptualized	Vocabulary measurements	Reading comprehension measurements	Analysis/Results
Pulido, 2007	99 L1 English speaking students at various levels of Spanish as a foreign language (beginner, intermediate, advanced). Location is not reported	RC proficiency →vocabulary knowledge Topic familiarity/RC→ vocabulary knowledge	**LexI, defined as:** **Intake:** ability to recognize having encountered target words (pseudowords) before **Vocabulary gain:** ability to provide or recognize L1 translation of a target word 2 days after encountering **Vocabulary retention:** ability to remember L1 translation after 28 days.	**Visual Recognition**- asked learners if they remembered seeing nonsense words in the passage or not in yes/no format. **Multiple choice receptive and productive vocabulary test**- measured the number of nonsense words inferred by having learners choose English translated definition from multiple-choices, or learners productively choose word that belongs with a definition	Overall reading proficiency: **Spanish version of Adult Basic Learning Examination**- 48 MCQs on functional (letters, signs, ads) and educational (expositions) texts that test literal comprehension and inferencing skills **Text comprehension:** written recall of familiar and unfamiliar passages in L1	Learners recalled more semantic propositions for the passage with higher topic familiarity (F(1, 196) = 6.39, p < .05, d = .36). Text comprehension had a larger effect size, F(1, 197) = 20.13, p < .0001, B = 1.95, r/k = .73 (gain), r/k = .61 (retention), than overall reading proficiency, F(1, 197)= 8.64, p < .01, B = 1.82, r/k = .64 (gain), r/k = .51 (retention), on vocabulary gain and retention.
Pulido, 2009	35 L1 English speaking university students at various levels of proficiency in Spanish as a foreign language (beginner, intermediate, high int, advanced, hi advanced)	RC/Topic familiarity → LexI/Vocabulary Retention, LexI ←→ vocabulary retention	**LexI:** Associating new forms with their functions or referents; processing and attention. **Target Word Episodic memory:** ability to recognize having seen a word before **Receptive retention of meaning:** ability to remember text forms and their L1 translation equivalents	Learners read a familiar and nonfamiliar passage with eight nonsense target words (TW) each**. Translation Production and Translation Recognition Task** test of TWs to measure meaning retention. lexical input processing, and lexical inferencing (participants wrote) meaning or translation of each TW read in a Spanish passage.	Overall reading abilities using the Spanish version of **Adult Basic Learning Examination**- 48 MCQs on functional (letters, signs, ads) and educational (expositions) texts that test literal comprehension and inferencing skills.	Using a mixed-model repeated measures ANCOVA, found that there was a significant impact of reading proficiency (F(1,33) = 93.56, p < .0001, η2 = .74) and topic familiarity (F(1, 33)) = 77.58, p < .0001, η2 = .70) on LexI. An ANCOVA also revealed a significant effect of RC (18.22, p <.0001, η2 = .36) and topic familiarity (10.54, p = .029, η2 = .14) on retention of target word meanings (only in

						recognition). Only RC had a significant effect on retention for target word production (16.52, p<.001, η2 = .33).

Note. The following abbreviations are used: Vocabulary Size (VS), Vocabulary Depth (VD), Lexical Inferencing (LexI), Reading Comprehension (RC), Vocabulary Knowledge (VK), Word Association Test (WAT), Vocabulary Levels Test (VLT), Lexical Inferencing (LexI)