

## The *virtuous* circle: Modeling individual differences in L2 reading and vocabulary development

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### Abstract

The present study investigated the relative contributions of experiential and ability factors to second language (L2) passage comprehension and L2 vocabulary retention. Participants included a cross section of 99 adult learners of Spanish as a foreign language enrolled in beginning through advanced level university Spanish courses. Participants completed a standardized reading proficiency test (Adult Basic Learning Examination, Spanish version) to verify a range in proficiency, a checklist and translation *passage sight vocabulary* test, and a written recall in the native language of the 4 passages that were read. Vocabulary retention was measured at 2 time intervals by a multiple-choice test of receptive retention of meaning of targeted vocabulary. Data were analyzed using structural equation modeling (SEM). Results revealed consistent support for the following model: (a) Language processing experience positively influenced L2 passage sight vocabulary; (b) L2 passage sight vocabulary positively influenced narrative passage comprehension; and (c) L2 comprehension positively influenced L2 vocabulary growth.

**Keywords:** sight vocabulary, reading comprehension, incidental vocabulary learning, SEM, language processing experience

What explains variance in second language (L2) reading comprehension ability and related literacy skills? Vocabulary knowledge is one important component of literacy. Vocabulary can develop as a byproduct of engaging in the component processes involved in reading, such as lower-level linguistic and higher-level discourse processing and its integration with prior knowledge. Such processing requires knowledge that is accrued through experience with the target language, as well as experience with everyday situations or specific subject matter (e.g., Ellis, 1994; Hu & Nation, 2000; Koda, 1989; Krashen, 1989; Laufer, 1997; Nagy, 1997; Nation, 2001; Pulido, 2003, 2004a, 2007, in press-b, in press-a; Pulido, Hambrick, & Russell, 2007). Nuttall (1982), and later Coady (1997), described the relationships among literacy skills, engagement in reading, and language learning as being both a *vicious circle* and a *virtuous circle*. On the one hand, it is a vicious circle because L2 readers who do not engage in frequent reading also tend to be weak in the requisite skills and knowledge sources required for reading. Such readers also lack sufficient experience with the target language. When weak readers do read, they stumble over words that they do not know, read slowly, and experience difficulty in following

the ideas contained within and across sentences. With such difficulty they become frustrated and develop a distaste for reading. This results in infrequent reading and inhibits potential growth of knowledge, such as linguistic knowledge. On the other hand, it is a virtuous circle in that with more L2 processing experience, learners become more efficient in the skills required for reading. They read more frequently and better, and are apt to experience more growth in knowledge from engaging in literacy activities.

At present, there is a lack of L2 research using sophisticated modeling frameworks to delineate the nature of the multi-componential cycle described above. The present study attempts to shed a new light on the nature of the cycle by uncovering in specific reading activities the simultaneous contributions of language processing experience and proficiency factors to L2 reading comprehension and vocabulary retention. The aim is to provide a more comprehensive model of L2 reading comprehension and vocabulary development through reading than what has been previously obtained through “single-focus” studies (Koda, 2005, p. 183).

### **Reading Comprehension**

Comprehension, a complex cognitive process, is central to acquiring a new linguistic system: Input must be decoded in some comprehensible fashion for second language acquisition (SLA) to occur. In the case of L2 reading comprehension, the reader uses previous knowledge to construct and integrate meaning from text (e.g., Bernhardt, 1991; Carrell, Devine, & Eskey, 1988; Grabe & Stoller, 2002; Koda, 2005, 2007; Nassaji, 2002; Swaffar, Arens, & Byrnes, 1991). During reading there is simultaneous cognitive processing involving pattern recognition, letter identification, lexical access, concept activation, syntactic analysis, propositional encoding, sentence comprehension, intersentential integration, activation of prior knowledge, information storage, and comprehension monitoring. According to connectionist models (e.g., Koda, 2005, 2007; Nassaji, 2002) the generic knowledge structures, or background knowledge, that are accessed during reading are largely determined by the quality of the textbase that the learner constructs. Textbase quality is affected by the individual’s text processing efficiency (i.e., ability in lower-level processes, such as word recognition and syntactic parsing) and working memory.

Comprehension processes and SLA processes, although somewhat overlapping, are also distinct. For example, comprehension involves constructing a mental representation from the propositional content for the purpose of understanding the message. However, in order for a linguistic system to be developed through comprehension activities, additional input processing must occur. Such processing entails making form-meaning connections from the input, or focusing attention on new forms and associating them with their functions or referents.

For vocabulary development through reading, readers must first notice that words are unfamiliar. Then, if deemed relevant enough for further processing, they must infer meaning using context cues and linguistic and extra-linguistic knowledge. The syntactic, semantic, and pragmatic knowledge that becomes activated and held in working memory during reading is then utilized on-line to constrain subsequent textual and lexical interpretations. This process is known as lexical bootstrapping (for the first language [L1] see Clark, 1993, and Sternberg, 1987; for the L2 see De Bot, Paribakht, & Wesche, 1997). When word meanings are not known during reading,

adult L2 learners may use whatever information is available to interpret them to the extent that their proficiency in the language enables them to use such information: all of the elements above function in tandem in generating initial form-meaning connections for new words during reading (see also Nagy, 1997; Nassaji, 2003; Paribakht & Wesche, 1999; Pulido, 2007, in press-b, in press-a; Pulido et al., 2007).

At the same time, readers must also pay sufficient attention to the connection between the meaning and the new word form. This involves some unspecified degree of elaborative rehearsal and association with previous knowledge (Baddeley, 1998). If there are too many constraints on the individual's processing capacity (Just & Carpenter, 1992; McLaughlin, 1987), characteristic of lower proficiency learners, or if unfamiliar words are not deemed important (Craik & Tulving, 1975), then these words may be processed more superficially and are less likely to be retrieved from memory (e.g., Ellis, 1994, 2001; Gass, 1999; Hulstijn, 2001, 2003; Laufer & Hulstijn, 2001; Robinson, 2003; Schmidt, 2001). That is, learners may be able to achieve general comprehension without having to attend to the formal properties of new words.

In sum, additional processing must be completed for vocabulary to develop through reading. Success in such processing presumably occurs as learners increasingly use the L2 and also as they gain more knowledge of the L2 itself. The following section discusses these crucial factors in more depth.

### **Language Processing Experience**

Language learning requires exposure to language and engagement in input processing through reading, writing, speaking, and listening. Frequency of exposure to language has been implicated as the key catalyst driving the acquisition of simple and complex, and concrete and abstract linguistic structures (e.g., Ellis, 2002, 2005). Foreign language exposure can be accomplished in various ways, from formal coursework activities to study abroad experiences. Exposure outside of the classroom can occur through various modes, including conversation, television or film viewing, or via literacy activities (e.g., book, magazine, and newspaper reading). With regard to forms of exposure to print,<sup>1</sup> Stanovich (e.g., 1986, 2000) has described how this might contribute to cognitive change, and, in particular, change in reading comprehension ability and vocabulary knowledge. The linguistic structures encountered through reading are qualitatively and quantitatively different from those encountered in common speech. Moderate-to low-frequency words and more complex linguistic structures appear more frequently in reading materials compared to everyday conversation (for the L1 see Biber, 1986, or Hayes, 1988; for the L2 see McCarthy & Carter, 1997; Nation, 2001; Schmitt, 2000). Print exposure has also been implicated in connectionist models of L1 reading, for example, Landauer and Dumais' (1997) latent semantic analysis. Their analysis demonstrated that vocabularies grow at very rapid rates through exposure and despite the lack of direct instruction in vocabulary. This serves as an example of the potential benefits of print exposure for L2 vocabulary learning, in addition to direct instruction.

Numerous studies of English and Spanish L1 literacy conducted with children and adults have demonstrated strong contributions of print exposure to reading ability, vocabulary and

orthographic knowledge, as well as other indices of verbal intelligence (e.g., Beech, 2002; Cipielewski & Stanovich, 1992; Cunningham & Stanovich, 1991; Echols, Stanovich, West, & Zehr, 1996; Gutierrez-Clellen & Kreiter, 2003; Lee, Krashen, & Tse, 1997; Rodrigo, McQuillan, & Krashen, 1996; Stanovich & West, 1989; West, Stanovich, & Mitchell, 1993). Findings of a strong reciprocal relationship between vocabulary knowledge and reading ability led Stanovich (1986) to conclude that the amount of exposure to print outside of school was a key contributing factor in causing achievement differences that were observed inside the classroom. He subsequently concluded that “the differential reading skills thus acquired enable differential bootstrapping of further vocabulary, knowledge, and cognitive structures outside of school” (Stanovich, 2000, p. 151). In native language studies, other avenues of language exposure (e.g., television and film viewing or everyday conversation) have not contributed to literacy development and content knowledge as robustly as print exposure. In fact, television viewing accounted for no additional variance in general knowledge after controlling for intelligence, verbal and non-verbal ability (e.g., Stanovich & Cunningham, 1993). In some studies it even resulted in negative correlations with vocabulary knowledge in readers and non-readers, and individuals high and low in print exposure (e.g., West et al., 1993).

Similar arguments for the benefits of language exposure and reading have also been applied to the L2 context. For example, Ellis (1994, 2002) and Krashen (1989, 2004) have described the phenomenon of the rich getting richer for L2 vocabulary acquisition through reading and the effects of frequency of exposure on SLA.<sup>2</sup> There are numerous correlational studies associating greater gains on measures of L2 literacy (e.g., orthographic, phonological, vocabulary, and grammar knowledge, and reading proficiency) with increased exposure to the foreign language, especially through extensive reading activities (e.g., Constantino, Lee, Cho, & Krashen, 1997; Elley, 1991; Elley & Mangubhai, 1983; Haynes & Carr, 1990; Kim & Krashen, 1997; Lee, Krashen, & Gibbons, 1996; McQuillan, 2006; Pulido et al., 2007). In the case of foreign language learning, additional exposure to language through speaking and listening should also be beneficial to L2 literacy development, unlike in the case of the L1 studies.<sup>3</sup> As L2 learners advance in formal language study, they also engage in more speaking and listening activities (e.g., through literature, culture, film, and conversation courses). Such exposure should increase the frequency with which they encounter more varied vocabulary and complex language structures. In turn, this should be beneficial in promoting automaticity in processing such structures. Thus, it appears that the amount of exposure to language is a significant factor in contributing to gains in literacy.

### **Passage Sight Vocabulary**

Stanovich (1986) argued that the key mechanism allowing for capacity to be allocated to comprehension during reading was efficient decoding and word recognition skills. L2 reading research has also demonstrated the importance of word recognition efficiency and general vocabulary knowledge in reading development (e.g., Koda, 1989, 2005, 2007; Laufer, 1992; Laufer & Sim, 1985; Mecartty, 2000; Ulijn & Strother, 1990). For instance, Laufer (1997, p. 21) suggested that for L2 readers the “threshold for reading comprehension is, to a large extent, lexical”. Likewise, a general vocabulary knowledge threshold has also been reported for learning vocabulary through reading (Haynes & Baker, 1993; Horst, Cobb, & Meara, 1998; Nassaji,

2004). Yet, crucial to reading and lexical input processing is knowledge of vocabulary specifically associated with the passages, or *passage sight vocabulary* (Pulido, 2000, 2003, 2004b, 2007, in press-b).<sup>4</sup> Passage sight vocabulary has been largely ignored in reading research (see Bernhardt, 2004). The more knowledge that readers have of the vocabulary specific to a given passage (i.e., the higher the text coverage), the more comprehensible the input becomes. And, with sufficient passage sight vocabulary and efficient decoding and word recognition skills, readers can then allocate attentional resources to engaging in other required text comprehension processes such as parsing sentences, constructing and integrating ideas from context, using information from long-term memory, and monitoring comprehension. That is, passage sight vocabulary fuels comprehension processes and results in a greater likelihood of successful lexical inferencing and further lexical growth. Without such knowledge and efficiency, readers are apt to experience a short circuit—that is, a failure to understand the relationships among ideas in the text, to monitor comprehension, and to infer and integrate new meaning. Ultimately, this will result in fewer chances for vocabulary development (e.g., Grabe & Stoller, 2002; Koda, 2005, 2007; Laufer, 1997).

Several studies using think-aloud tasks have elicited the knowledge sources that L2 readers use during reading. They observed that weaker learners experienced more difficulty in integrating multiple textual cues and background knowledge than stronger learners, who appeared to know more words in the context (e.g., Haynes, 1993; Haynes & Baker, 1993; Lee & Wolf, 1997; Parry, 1997; Rott, 2000). These results were determined by anecdotal observations, rather than quantitative measurements of the vocabulary contained within the passages. There is scant published empirical evidence illustrating the precise relationship between vocabulary knowledge specific to a given text and lexical development associated with processing that text. Pulido (2003, 2004b, 2007) investigated the role of passage sight vocabulary in vocabulary development through reading. Passage sight vocabulary was measured by a combination self-report of familiarity with non-target words in a passage and an L2-L1 translation test of the words in the passage for which participants had reported prior familiarity. In Pulido's (2003) study with a cross-section of L2 learners of Spanish, the results revealed a significant role of passage sight vocabulary on measures of lexical gain (L2-L1 translation production and L2-L1 translation recognition) 2 and 28 days after reading. In a different cross-sectional study, Pulido (2007) found significant effects of passage sight vocabulary on measures of lexical inferencing, difficulty in lexical inferencing, and receptive retention of target word (TW) meanings. These results were obtained even after a verification task to confirm or correct the guesses that had been made. In addition, the learners of the group with greater levels of sight vocabulary also reported greater ease in guessing the TWs from the more familiar story. These combined findings concerning passage sight vocabulary underscore the importance of knowledge of vocabulary specific to passages as one of many knowledge sources critical to successful reading comprehension and lexical input processing.

The preceding review establishes that individual differences in vocabulary arise from a number of factors, some of which include L2 language processing experience, L2 passage comprehension, as well as preexisting L2 passage sight vocabulary. Therefore, the following questions were addressed:

1. Does L2 language processing experience positively contribute to L2 passage sight

vocabulary knowledge?

2. Does L2 passage sight vocabulary knowledge positively contribute to comprehension of L2 passages containing such vocabulary?

3. Does L2 reading comprehension positively contribute to L2 vocabulary growth through reading?

We hypothesized the following relations among these factors: (a) L2 language processing experience positively contributes to L2 passage sight vocabulary knowledge; (b) L2 passage sight vocabulary knowledge positively contributes to comprehension of passages containing such vocabulary; and (c) L2 reading comprehension positively contributes to L2 vocabulary growth through reading.

## Method

### *Participants*

Ninety-nine adult English-speaking learners of Spanish served as participants. They were recruited from three distinct university course levels: beginning (2<sup>nd</sup>-semester elementary Spanish),  $n = 43$ ; intermediate (5<sup>th</sup>-semester composition),  $n = 39$ ; and advanced (8<sup>th</sup>-semester literature),  $n = 17$ . Table 1 summarizes additional participant characteristics. The participants represented a wide range of Spanish reading ability, as measured by the Spanish version of the Adult Basic Learning Examination (ABLE); total scores ranged from 18 to 47 ( $M = 35.6$ ,  $SD = 8.0$ ,  $Max = 48$ ). It can also be seen that the subjects had diverse Spanish language learning backgrounds, both through formal instruction and through studying and living abroad.

Table 1. *Background characteristics of participants*

Variable	Total ( $N = 99$ )		Beginning ( $n = 43$ )		Intermediate ( $n = 39$ )		Advanced ( $n = 17$ )	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
ABLE score	35.6	8.0	28.0	5.2	40.1	4.1	43.1	2.2
Years of Spanish study	4.4	3.1	1.4	1.2	6.6	1.8	6.9	2.0
No. of Spanish courses	4.2	3.5	2.0	0.0	3.6	1.5	11.2	2.0
Age of starting Spanish study	15.3	6.1	19.3	5.8	12.2	4.2	12.4	5.0
Study abroad in L2 country (%)	22.2	–	2.3	–	12.8	–	94.0	–
Visit L2 country (%)	48.5	–	39.5	–	56.4	–	52.9	–

*Note.* ABLE = Adult Basic Language Examination reading proficiency test (Spanish version).

### *Materials*

*Reading passages.* An incidental learning research paradigm was used. The term *incidental learning* is used simply to refer to the specific research paradigm (e.g., Hulstijn, 2001, 2003) where, in the orienting instructions, there was no mention of an upcoming vocabulary test. This paradigm was chosen in order to approximate real world reading, where readers do not typically

read for the purpose of taking a vocabulary test afterward, but rather for comprehending the passage as a whole.

The texts used for the present study were four contrived script-based narrative passages, two depicting more familiar scenarios, and two depicting less familiar scenarios (for examples of the passages, methodology to create them, and familiarity ratings see Pulido, 2003). By including passages ranging in familiarity to learners based on their background knowledge we were able to provide a more generalizable test of a model, as opposed to simply including either familiar or unfamiliar passages. *El viaje al supermercado* (“The Trip to the Supermarket”) and *La cita con el médico* (“The Doctor’s Appointment”) were based on scenarios considered to be routine and very familiar to the participants, based upon their experience. The two less familiar passages, *La publicación de un artículo* (“Publishing an Article”) and *Comprando una casa* (“Buying a House”) were based on scenarios that were regarded as less familiar to participants, based upon their experience. All of the stories conformed to a temporally ordered set of activities pertinent to the scenarios at hand. In addition, within each scenario there were particular roles and objects associated with the actions involved in the story; that is, each familiar story was loosely centered around a script purported to be stored in participants’ long-term memory (Graesser, Singer, & Trabasso, 1994; Schank & Abelson, 1977). All stories were of similar sentence and text length and were, in general, structurally comparable. Each of the four passages was submitted to a semantic propositional analysis (e.g., Kintsch, 1998). A comparison of various text features of each story is found in Table 2.

Table 2. *Characteristics of passages*

	Grocery shopping	Doctor’s office	Publishing article	Home buying
Length (words)	174	168	164	172
ASL	10.89	9.88	10.25	10.11
<i>Que</i> clauses	1	2	2	2
Object pronouns	3	9	6	3
Reflexive pronouns	1	8	1	4
Semantic Propositions	58	55	45	46
Familiarity rating <sup>a</sup>	4.9	4.7	2.2	2.6

Note. ASL = average sentence length.

<sup>a</sup>Familiarity with the activities in the situation and their order was rated on 5-point scale (1 = *very unfamiliar* to 5 = *very familiar*).

*Target words.* The TWs were 32 nonsense words (6 nouns and 2 verbs per story) that represented concepts frequently associated with the story scenarios (for a complete list see Pulido, 2003). The nonsense words were invented words constructed according to orthographic and morphological rules of Spanish. These were used to ensure that no learner had prior knowledge of the TWs. Each TW appeared only once in each story, and there were no definitional context clues provided for any of them.

*Language processing experience.* Language processing experience was measured through a background questionnaire administered to all participants (see Appendix A). Four questions tapped language processing experience outside of formal learning experience (i.e., the number or type of Spanish courses taken). Participants were asked to estimate the amount of time (hours per

week) that they spent in reading, writing, speaking, and listening outside of their class time. Similar questionnaires have been used in reading research (e.g., Dewey, 2004; Freed, Dewey, Segalowitz, & Halter, 2004).

*L2 reading proficiency.* Efficiency in reading ability is crucial for lexical bootstrapping. To ensure that there was a sufficient range of proficiency that was captured by our cross-sectional sample we assessed L2 reading proficiency, in addition to obtaining information about course level membership. The measure used was the Spanish version of the ABLE (Karlsen & Gardner, 1990) reading comprehension section. This is a timed test (i.e., 35 minutes) containing readings of a functional (e.g., letters, signs, ads, etc.) and educational (e.g., expositions) nature. The 48-item multiple-choice measure contains 24 items that test literal comprehension ability (i.e., ability to understand what is explicitly stated in the texts, that is a text-based dimension) and 24 items that test inferential comprehension ability (i.e., ability to make inferences and draw conclusions from what is not explicitly stated, that is, a situation-model dimension).

*L2 passage sight vocabulary.* Previous knowledge and familiarity with non-target vocabulary within each passage was tested via a self-report and translation (Spanish to English, L2-L1) measure. The first subcomponent consisted of a *yes* or *no* checklist to determine self-reported familiarity with the lexical items, while the second component was a translation (L2-L1) to measure previous knowledge of the meanings of words reported as being familiar. Since it was not feasible to test every single word type from each of the four passages, we counted the amount of new word tokens for each story. From this figure we then estimated which words were likely to be known by all learners. These words primarily included high frequency function words (e.g., *el, la, en*) and cognates (e.g., *supermercado, clínica, publicación, visitar*). After excluding these items, the remaining percentage of non-target words selected from each story and randomly included in a 125-item test was as follows: (a) grocery, 48%; (b) doctor, 45%; (c) publishing, 42%; and (d) home buying, 43%.

*Text comprehension.* After reading each story participants completed a free written recall in their L1 (English). They were asked to write down as much information as possible without looking back at the passage. Each passage was first divided into complex propositions reflecting its semantic content (i.e., the predicate-argument schema), adapting methodologies from Kintsch (1998) for native language reading, and Barry and Lazarte (1998) for L2 reading (see Appendix B for a sample of the propositional breakdown). Propositional analyses such as these represent the semantic content of the text (i.e., the textbase), rather than the surface form or rhetorical organization of the passages. This methodology has received support in the psychological literature due to the psychological reality and validity of propositions (e.g., Chen & Donin, 1997; Kintsch, 1998; Underwood & Batt, 1996). In addition, a two-tiered hierarchy was adopted whereby propositions containing a verb as a relational term were worth 2 points. Propositions with an adverb or connective as the relational term were worth 1 point.<sup>5</sup> Each proposition was scored according to the following system: (a) maximum points awarded for mentioning the gist of the proposition (e.g., predicate and all arguments), (b) half of all possible points awarded for mentioning a fragment of the proposition (e.g., predicate and/or some of the arguments), and (c) no points awarded if there was no mention whatsoever of the proposition. Level of text comprehension was calculated by first tabulating the percentage of semantic propositions correctly recalled by each participant on each passage, then tabulating the average across the four



stories.

*Vocabulary retention.* Target word vocabulary gains from reading the four passages were measured at two distinct time intervals (e.g., 2 and 28 days after reading the passages). An L2-L1 translation recognition multiple-choice test was administered to measure receptive retention of meaning. One test form contained all 32 nonsense TWs, with each of the verbs in their infinitival forms, and the nouns in their original text forms. The order of presentation of the 32 TWs was randomized. Two test formats were subsequently created by reversing the order of presentation of the items. The multiple choice options were written to emphasize semantic, not syntactic, differences. They included four possible English (L1) translations, and a fifth option, *I don't know*. Among the four L1 translation options was the correct translation of the TW and three distracters. Each distracter conformed to at least one of the following criteria: (a) contextually proximate to the TW, (b) schematically appropriate, and (c) orthographically or phonologically close to another known word in the L1 or L2 and plausible for the given context. There were no options that were conceptually bizarre. Finally, where possible, the TW translations also appeared as distracters for other test items in order to minimize the likelihood of participants picking up associations between the TWs and their definitions from the test alone.

### *Procedure*

There were four separate data-gathering phases. During Session 1 all participants completed tests and questionnaires designed to measure the predictor constructs in the following order: (a) background questionnaire, (b) L2 passage sight vocabulary test, (c) topic familiarity questionnaire, and (d) ABLE reading proficiency test. Session 2 was conducted approximately one week later, at which time all participants read all four stories. Each story was followed by a written recall in the L1 (English). During Session 3, conducted two days after Session 2, all participants completed the L2-L1 translation recognition measure to assess vocabulary retention. At session 4, conducted 28 days after reading the passages, the same multiple-choice vocabulary retention instrument was administered, as in Session 3. The order of presentation of the narratives was counterbalanced across all participants, as was the assignment of test formats at the different testing intervals. Before reading each passage all participants were instructed to read for the purposes of answering comprehension questions about the stories. There was no mention of the vocabulary learning focus of the study.

## **Results**

We screened the data for univariate outliers on a variable-by-variable basis, where an outlier was defined as a value more than 3.5 standard deviation units from the variable mean. There were five such values, which we replaced with a less extreme value of 3.5 standard deviation units from the variable mean.

### *Descriptive Statistics and Correlations*

Descriptive statistics and correlations are displayed in Table 3 for the language experience, Table 4 for the passage sight vocabulary and passage comprehension variables, and Table 5 for the

vocabulary retention variables. Table 5 illustrates that the average rate of vocabulary learning was rather low. However, there was observed variation in the scores, which ranged from 0 to 6 points (75%) out of a maximum of 8 points. This indicates that rates were rather high for some learners. Internal consistency estimates were quite high ( $R^2$ s > .50) for all of the variables, indicating acceptable reliability. The correlations among the passage sight vocabulary variables (average  $r = .94$ ) and among the passage comprehension variables (average  $r = .77$ ) were uniformly high, indicating that the measures captured the same construct, as intended.

Table 3. *Descriptive statistics and correlations for language experience variables*

	<i>M</i>	<i>SD</i>	1	2	3	4
1. Reading (hours/week)	2.9	3.4	(.66)			
2. Writing (hours/week)	2.5	3.2	.78	(.64)		
3. Speaking (hours/week)	2.1	4.1	.54	.58	(.49)	
4. Listening (hours/week)	2.3	3.8	.58	.44	.69	(.50)

Note. Values along the diagonal are estimates of internal consistency reliability ( $R^2$ s). Correlations are statistically significant at .21 for the .05 level and at .30 for the .01 level.

Table 4. *Descriptive statistics and correlations for passage sight vocabulary and passage comprehension variables*

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
Sight vocabulary										
1. Publishing article	0.55	0.28	(.89)							
2. Home buying	0.48	0.25	.94	(.96)						
3. Grocery shopping	0.48	0.24	.90	.96	(.93)					
4. Doctor's office	0.51	0.28	.93	.96	.94	(.93)				
Passage comprehension										
5. Publishing article	0.31	0.17	.58	.58	.51	.55	(.67)			
6. Home buying	0.43	0.19	.57	.62	.58	.57	.73	(.73)		
7. Grocery shopping	0.46	0.22	.70	.71	.67	.70	.80	.81	(.78)	
8. Doctor's office	0.42	0.20	.72	.72	.67	.73	.69	.78	.78	(.67)

Note. Sight vocabulary variables reflect proportion correct; passage comprehension variables reflect number of propositions recalled. All correlations are statistically significant ( $p < .01$ ).

Table 5. *Descriptive statistics and correlations for vocabulary retention variables*

Vocabulary retention variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
<i>Time 1</i>										
1. Publishing Article	1.7	1.4	(.31)							
2. Home Buying	2.4	1.7	.49	(.31)						
3. Grocery Shopping	2.7	1.7	.36	.29	(.18)					
4. Doctor's Office	2.3	1.4	.38	.42	.34	(.25)				
<i>Time 2</i>										
5. Publishing Article	1.8	1.5	.43	.44	.22	.38	(.28)			
6. Home Buying	2.5	1.6	.32	.62	.37	.45	.47	(.37)		
7. Grocery Shopping	2.2	1.6	.34	.34	.49	.24	.26	.47	(.24)	
8. Doctor's Office	2.1	1.5	.37	.34	.30	.49	.41	.41	.32	(.24)

Note. Maximum retention score = 8. Values along the diagonal are internal consistency estimates ( $R^2$ s).

Variables reflect proportion correct. All correlations are statistically significant ( $p < .01$ ).

By contrast, although correlations among the language experience variables were all positive, the reading and writing variables correlated more strongly with each other ( $r = .78$ ) than with the speaking and listening variables, and vice-versa for the speaking and listening variables ( $r = .69$ ), suggesting the existence of distinct language experience factors. (We test for this possibility in the next section). Finally, internal consistency estimates were somewhat low ( $.18 \leq R^2s \leq .37$ ) for the vocabulary retention variables, but correlations of the measures across testing occasions (i.e., test-retest correlations) were at least moderate in magnitude ( $.43 \leq rs \leq .62$ ). Thus, overall, there was evidence that all of the variables had adequate reliability.

### *Structural Equation Modeling*

Structural equation modeling (SEM) is a statistical approach that comprises two core techniques—factor analysis and path analysis—and affords two major advantages over other approaches that we could have used to analyze the data (e.g., multiple regression). First, SEM permits use of *latent variables*. Along with random error, it must be assumed that virtually any psychological variable, no matter how carefully measured, will reflect two types of influence: those that originate from the construct of interest and those that are specific to some task. Latent variables reflect only the variance common to a number of measures of some construct; task-specific influences are statistically canceled out. Second, SEM permits the researcher to model relations, both causal and non-causal, among multiple variables simultaneously.

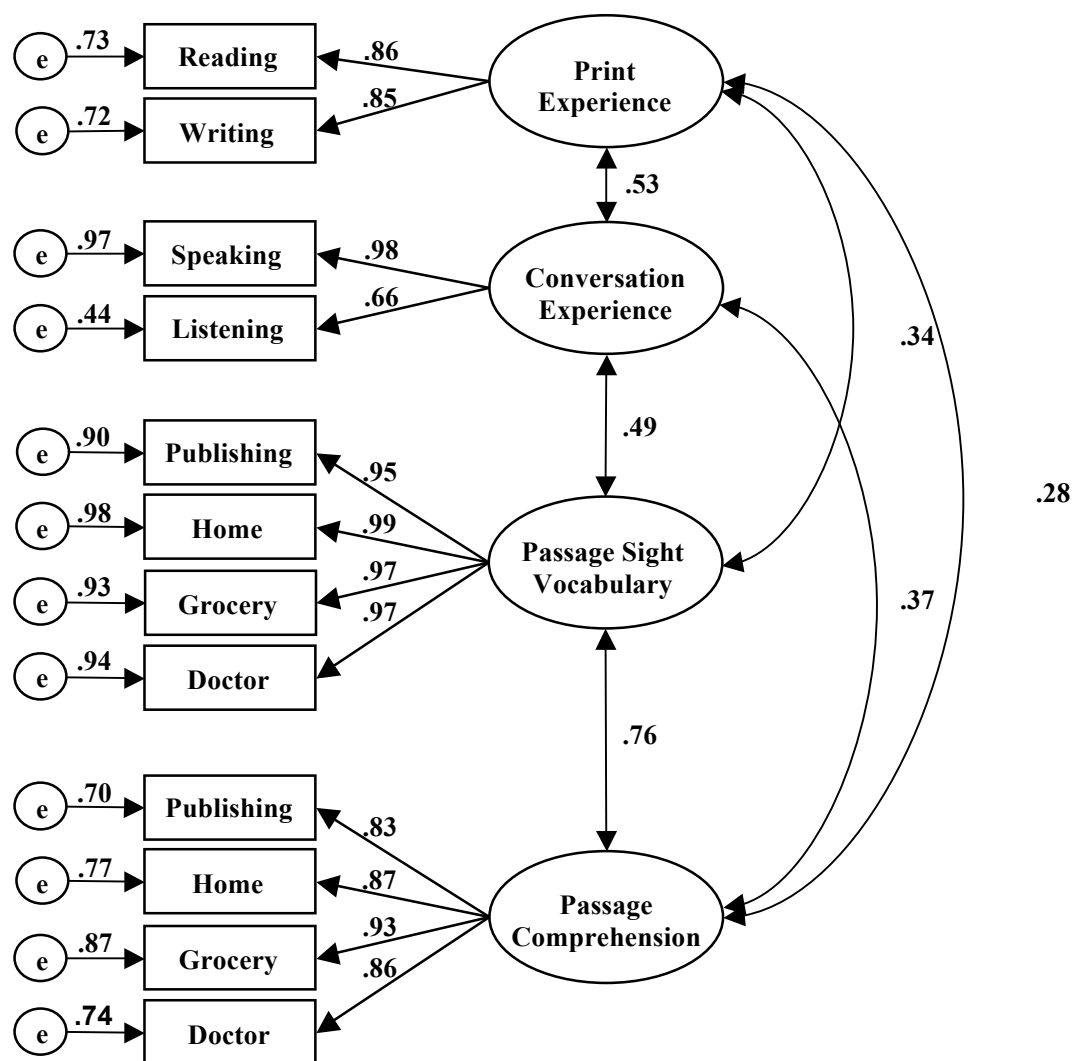
Throughout this section, we report a number of statistics to characterize model fits. The  $\chi^2$  test indicates whether there was a significant difference between the reproduced and observed covariance matrices. Thus, non-significant  $\chi^2$ s reflect a fit of the model to the data. However, even slight differences between reproduced and observed covariance matrices can result in significant  $\chi^2$ s, and additional fit statistics are typically reported. The comparative fit index (CFI) and non-normed fit index (NNFI) reflect improvement in the fit of a model over a baseline model in which covariances among observed variables are assumed to be zero. The root mean squared error of approximation (RMSEA) reflects the average difference between the observed and reproduced covariances. CFI and NNFI values of greater than .90, and RMSEA values less than .08, indicate acceptable fit (Kline, 2005). The sample size ( $N = 99$ ) in this study was somewhat, though not extremely, small for SEM, and therefore we report standard errors for all parameter estimates from the models in the Appendix C.

As an additional step to prepare the data for the structural equation modeling, we inspected skewness and kurtosis values to see whether the variables were approximately normally distributed; values were near zero for all variables, except the estimates of language experience, which tended to be positively skewed ( $> 2$ ). To address this, we added a constant to each value to remove zeros, and then we performed a log transformation on each variable; the distributions were approximately normal (skewness values  $< 1.5$ , kurtosis values  $< 1$ ), and thus we use the transformed variables in all subsequent analyses.

### *Confirmatory Factor Analyses*

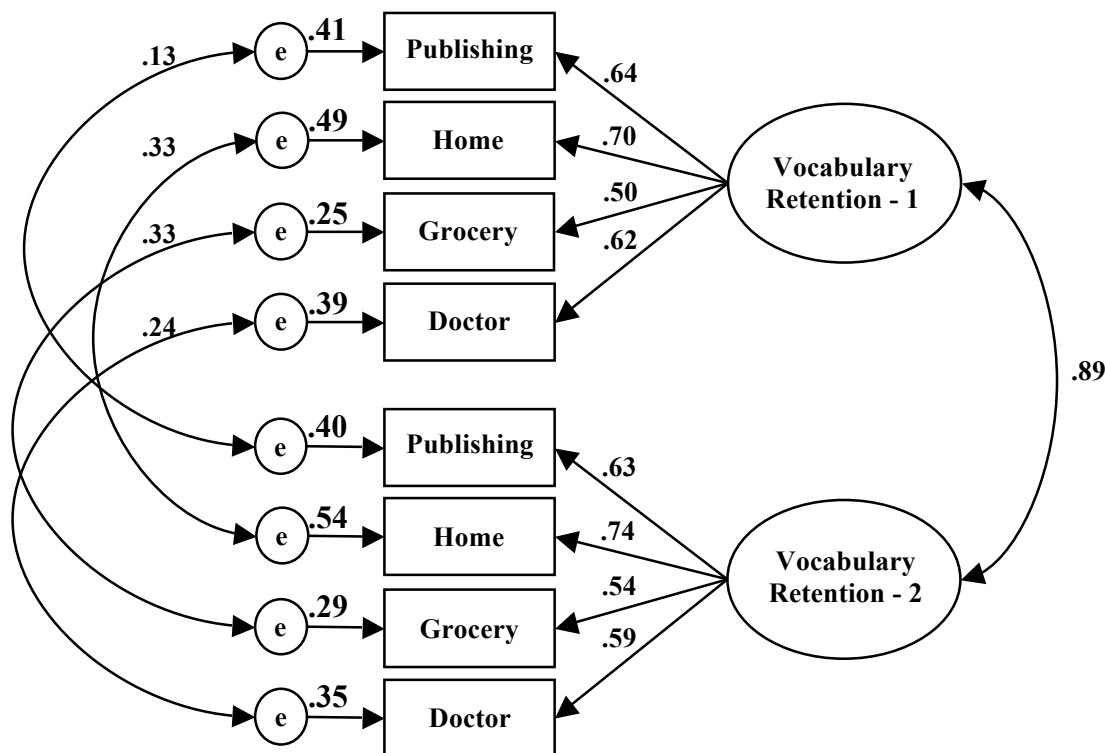
We analyzed the data in two steps. With separate analyses for the predictor variables and

criterion variables, the first step was to perform confirmatory factor analyses to see whether the constructs of interest were adequately measured. Initially, we specified a model with three factors: language experience, passage sight vocabulary, and passage comprehension. Model fit was not particularly impressive:  $\chi^2(51) = 146.59$  ( $p < .01$ ), CFI = .93, NFI = .89, RMSEA = .14. Consistent with the pattern of correlations noted above, modification indices suggested that this was because *language experience* comprised distinct factors, which seem to reflect *conversation experience* (i.e., speaking and listening) and *print experience* (i.e., reading and writing). We added these two factors to the model. Model fit was just at the level considered acceptable,  $\chi^2(48) = 97.05$  ( $p < .01$ ), CFI = .96, NFI = .93, RMSEA = .10, and critically, the improvement in fit over the three-factor model was highly significant:  $\Delta\chi^2(3) = 49.54$  ( $p < .01$ ). As shown in Figure 1, each variable had a strong positive loading on a factor, and the factors were moderately intercorrelated.



**Figure 1.** Measurement model for predictor variables. Values adjacent to single-headed arrows are standardized regression coefficients; values adjacent to double-headed arrows are correlation coefficients. *e* = error; values reflect proportion of variance accounted for in observed variables.

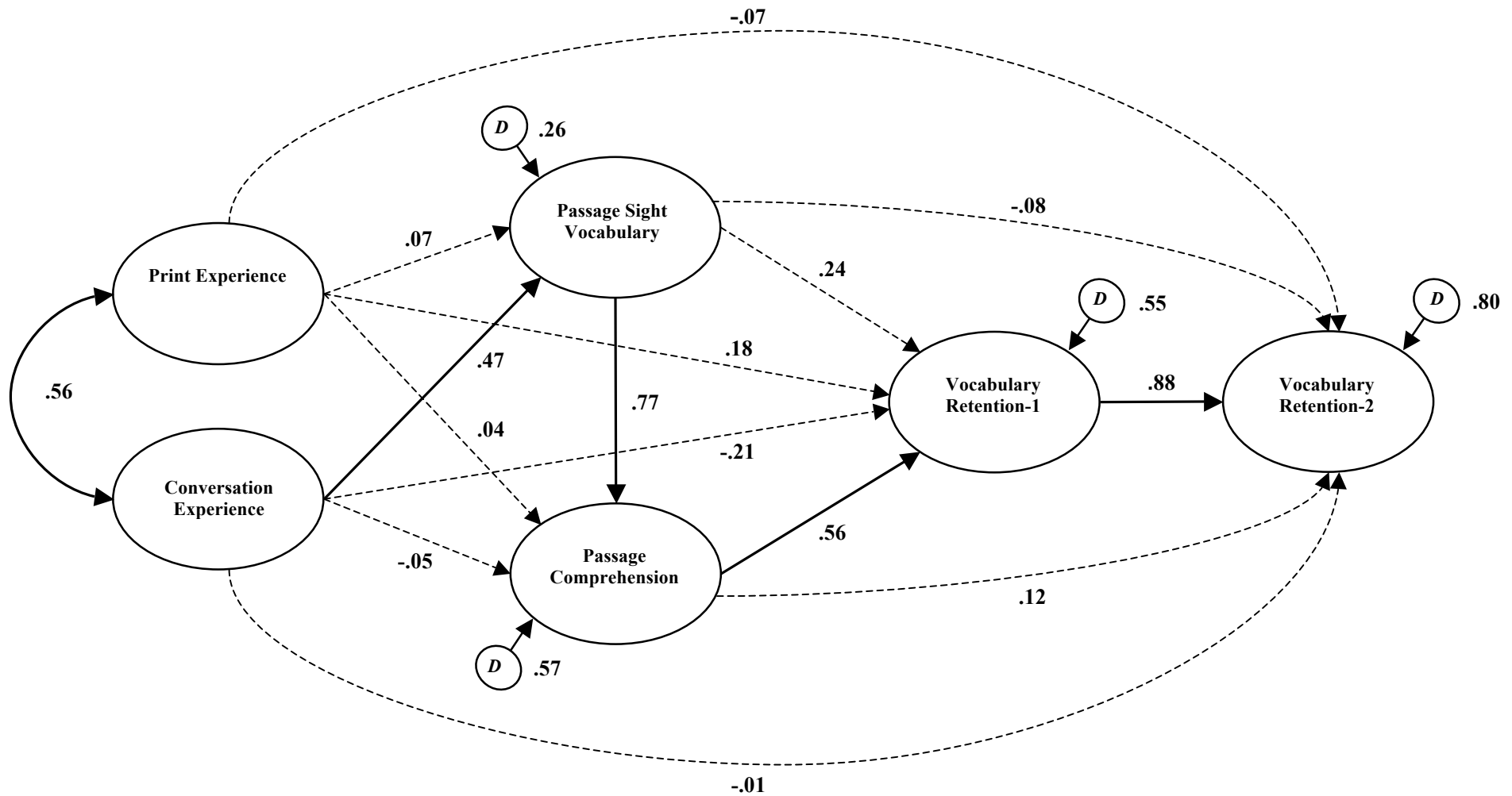
For vocabulary retention, we tested a two-factor model (Time 1 and Time 2). We allowed the error terms for each passage to correlate across time. This allowed us to estimate the stability of vocabulary from Time 1 to Time 2, while controlling for passage-specific factors (e.g., greater interest in one passage than the others). Model fit was excellent,  $\chi^2(15) = 15.68$  (*ns*), CFI = 1.00, NFI = .94, RMSEA = .02. As shown in Figure 2, the Time 1 x Time 2 correlation was very high,  $r = .89$ . However, constraining this correlation to unity (1.0) significantly decreased model fit,  $\Delta\chi^2(1) = 4.24$ ,  $p < .05$ , and thus we were justified in treating the factors as distinct.



**Figure 2.** Measurement model for vocabulary retention variables. Values adjacent to single-headed arrows are standardized regression coefficients; values adjacent to double-headed arrows are correlation coefficients. *e* = error; values reflect proportion of variance accounted for in observed variables.

*Structural Model*

The second step was to test for relations among the latent variables in a structural model. The model is displayed in Figure 3. Conversation experience positively contributed to passage sight vocabulary (.47), whereas the contribution of print experience, though positive, was near zero (.07). In turn, passage sight vocabulary strongly contributed to passage comprehension (.77), accounting for nearly 58% of the variance. The direct contributions of both conversation experience (.04) and print experience (-.05) on passage comprehension were near zero, and thus their contributions were almost entirely mediated through sight vocabulary. Finally, passage comprehension positively contributed to vocabulary retention-1 (.56), and even more strongly to vocabulary retention-2 (.88). Collectively, the predictor variables accounted for 51% of the variance in vocabulary retention-1 and 80% of the variance in vocabulary retention-2. Overall model fit was acceptable,  $\chi^2(193) = 307.88$  ( $p < .01$ ), CFI = .94, NFI = .86, RMSEA = .08.



**Figure 3.** Structural equation model predicting vocabulary retention. Values adjacent to single-headed arrows are standardized regression coefficients; values adjacent to double-headed arrows are correlation coefficients. *D* = disturbance; values reflect proportion of variance accounted for in latent variables. Solid paths are statistically significant ( $p < .05$ ).

These results provide support for the role of language experience in vocabulary acquisition through reading—and especially speaking and listening—and suggest that input processing and comprehension do indeed contribute to vocabulary acquisition.

## Discussion

The aim of the study was to investigate the vicious and virtuous circle that has been observed in L2 reading. Toward this end, we tested for relationships among literacy skills, engagement in reading, and subsequent language learning. This was accomplished, first, by observing performance from a cross-section of L2 learners on a range of tests and questionnaires that observed these constructs, and, second, through the use of multivariate statistical modeling. The factors deemed relevant to modeling the vicious and virtuous circle included L2 processing experience and L2 passage sight vocabulary.

### *Empirical Evaluation of the Vicious and Virtuous Circle*

The results expand upon previous single-focus research with respect to the roles of the different variables in L2 reading comprehension and vocabulary acquisition through reading. Overall, the findings provide some evidence for the cycle depicted in the introduction part and also lend support for connectionist models of L2 reading (e.g., Grabe & Stoller, 2002; Koda, 2005, 2007; Nassaji, 2002). Connectionist models of reading emphasize that language processing experience and efficiency in lower-level linguistic processing are the driving forces behind successful performance on reading and related literacy tasks. Current SLA theories (e.g., Ellis, 2002, 2005) also argue that L2 knowledge and skills develop through language processing frequency and exposure. In the present study, the readers of the group who most frequently engaged in L2 language use in the different modalities also demonstrated correspondingly high levels of vocabulary knowledge related to the reading passages. Efficiency in linguistic processing presumably allowed these learners to engage in the higher level processes that were necessary for successful passage comprehension, which included literal and inferential comprehension abilities. In turn, this positively influenced the lexical bootstrapping processes required for vocabulary to be learned from context.

*Language processing experience.* From the standpoint of the predictor variables, the results first revealed that language processing experience, measured by self-reports of engagement in literacy and conversation activities, contributed to a more proximal cause of narrative comprehension and vocabulary development through reading (i.e., L2 passage sight vocabulary). Results revealed a moderate contribution of self-reported engagement in speaking and listening activities to the L2 literacy skills. This finding contrasts with L1 reading studies described above (e.g., Stanovich, 2000). The participants of the present study were foreign language learners who resided in a Midwestern city with few opportunities for day-to-day L2 use. It is assumed that at the time of data collection their exposure to the L2 occurred primarily through their Spanish classroom-based activities and course assignments. This type of speaking and listening exposure likely contrasts with that reported for the child participants in the L1 reading research reported above. In those studies engagement in speaking and listening activities outside of the classroom (e.g., through play, television, everyday conversation) did not explain any additional variance in

literacy development (and sometimes correlated negatively with literacy outcomes). In addition, the majority of the students in the present study had participated in study and living abroad experiences in a Spanish-speaking country at some point in their language learning experience. Such experiences should also indirectly exert a positive influence on subsequent language use and language learning outcomes, especially the learning of the type of language that corresponds to everyday scenarios.

These results provide new evidence of the role of L2 processing experience in L2 reading and vocabulary learning, outside of measures of print exposure. Previous studies have failed to obtain significant contributions from self-report questionnaires on language use habits (e.g., Dewey, 2004; McQuillan, 2006). However, the present study differed from previous research in several ways. First, compared to Dewey's study, we tested a larger participant pool representing a cross-section. We also used a broader and different type of measure of L2 reading proficiency to establish a range of proficiency. In addition, our participant pool was learning Spanish as a foreign language, compared to McQuillan's bilingual language minority ESL high-school students. The present results also suggest that a simple questionnaire eliciting language use habits can predict, to some extent, literacy skills related to comprehension and vocabulary learning outcomes. The discussion below concerns the significance of more proximal causes of reading comprehension and vocabulary learning through comprehension.

*Passage sight vocabulary and comprehension.* The results also revealed significant contributions of processing skills associated with reading to specific L2 reading comprehension activities and vocabulary acquisition via reading. It has been repeatedly argued and illustrated in L1 and L2 studies that engagement in reading activities, and also extensive reading programs, contributes to the development of general vocabulary knowledge (e.g., Krashen, 1989, 2004; Nagy, 1997; Stanovich, 1986, 2000), and vice versa. The present study expands upon this research and illustrates that as passage sight vocabulary knowledge improves, so too does subsequent cognitive processing performance that requires such sight vocabulary, namely, passage comprehension and lexical bootstrapping of new vocabulary.

As expected and predicted by connectionist models of L2 reading and language learning, L2 passage sight vocabulary positively contributed to narrative comprehension and vocabulary learning through comprehension. This finding provides new evidence of the role of vocabulary specifically related to the passages in predicting reading comprehension outcomes, following Bernhardt's (2004, 2005) suggestion to account for such knowledge and variation in L2 literacy development. Although we recognize that there is variance yet unexplained by the model, our results underscore the importance of word recognition skills and efficiency in linguistic and lower-level knowledge in enabling the use of higher-level processing skills, such as comprehension monitoring, inferencing, lexical bootstrapping, and storage of new linguistic information (e.g., Coady, 1997; Grabe & Stoller, 2002; Koda, 2005, 2007; Laufer, 1997). The passage sight vocabulary measure required learners to quickly indicate their familiarity with words contained within the passages, and then to provide a translation or definition of those words. Interestingly, although many learners (especially at the lower levels) indicated familiarity with words on the list, they often incorrectly translated or defined those words. This demonstrated inefficiency in word recognition skills, which was hypothesized to be relevant to subsequent reading performance.



As a complex cognitive skill, reading entails the simultaneous use of various knowledge sources and abilities, as described in the introduction part. The strong readers of the study could efficiently carry out the requisite lower-level processes, which presumably freed up attentional resources to enable the construction and integration of ideas from context, and the access to and use of background knowledge. These readers experienced greater success in inferencing and lexical gains through reading. In contrast, for the weak readers of the study both local comprehension and global comprehension were hampered. They were more apt to experience difficulty, or failure, in the construction and integration of ideas from context. Such difficulties were, in turn, connected with fewer vocabulary learning outcomes through reading.

### *Conclusions and Future Directions*

The results reported above reveal that L2 processing experience and passage sight vocabulary contribute to and account for a moderate amount of variance in L2 narrative reading comprehension and vocabulary development through comprehension. These results help to illustrate both the virtuous circle and the vicious circle of L2 reading and vocabulary learning through reading. To the best of our knowledge, this is the first such attempt to model adult L2 reading and lexical input processing through reading via structural equation modeling. At the same time, given that our predictor variables were measured at a single point in time, we caution that the results presented here are merely consistent with the particular account that we have described. An important goal for future studies is to use longitudinal approaches, along with statistical techniques like latent growth-curve modeling, to test causal models more directly. Specific issues that could be addressed in such studies include whether or not the results can be replicated with different genre of text (e.g., expository texts), and different measures of print and language exposure. In addition, it would be advantageous to include additional factors relevant to L2 reading and vocabulary learning through reading, such as working memory, L1 literacy, and other sources of linguistic knowledge (e.g., syntactic knowledge).

### *Pedagogical Implications*

On a final note, these results help to strengthen arguments for promoting extensive L2 reading and language use activities for L2 literacy development (both in and outside of classroom), in addition to direct teaching. It might be helpful to assign the following activities (which promote comprehension and context building, and focus on lower and higher level processing): previewing titles, headings, and illustrations for ideas in the text; scanning for specific information; reading the passage one section at a time and completing comprehension questions; selecting key words and local and global context cues; and identifying main ideas.

Teachers should also bear in mind that weaker readers may not learn as many new words, nor learn them as quickly, as stronger readers. Since lexical learning through reading does occur, but is a time-consuming endeavor, teachers should also continue to engage in direct teaching that draws learners' attention to new vocabulary and encourages additional processing, especially at lower levels of proficiency. Some possibilities include guessing and subsequently verifying meanings of new words through gloss consultation, dictionary and computer-assisted-language-learning (CALL) hyperlink consultation, or cooperative learning tasks. Finally, given the

findings, instructors should bear in mind the following practices to promote L2 reading and vocabulary development: match texts to learners based upon their vocabulary knowledge; dedicate time and resources to promoting frequency-based vocabulary and reading instruction through computer-aided resources; incorporate graded readers; and use texts or create materials with textual glosses, with particular emphasis on key words in the readings (e.g., Cobb, in press; Huang & Liou, 2007; Nation, 2001).

## Notes

1. Print exposure is the amount of time a person spends being visually aware of the written word, for example through reading newspapers, magazines, books, journals, scientific papers, and web materials. It has been typically measured via the Author Recognition Test (ART), Magazine and Newspaper Recognition Test (MRT), and Title Recognition Test (TRT). Alternative measures include diaries, self-report, retrospective questionnaires, quantity of foreign language courses taken, years of study of a foreign language, and study abroad experiences. See Dewey (2004) and Freed et al. (2004) for additional examples.
2. Admittedly, many of these studies deal with cognate languages or are connected with investigating the benefits of extensive reading programs (e.g., Krashen, 1989).
3. Relying on extensive reading and listening for vocabulary development is not as efficient as direct teaching because the learning rates are considerably lower (e.g., Nation, 2001).
4. Passage sight vocabulary knowledge can be contrasted with general vocabulary knowledge. Whereas the former refers to knowledge of words in a specific text and has been measured by L2-L1 translation and self-reported recognition tests (e.g., Pulido, 2000, 2003, 2004b, 2007), the latter refers to knowledge of vocabulary in general, and may or may not include words from a specific text that learners have been assigned to read.
5. Examples of connectives (CON) include (a) causal (*because, so*, etc.), (b) condition (*if-then*), (c) purpose (*to, in order to*), (d) concession (*but*, etc.), (e) conjunction (*and, also*, etc.), and (f) temporal (*first, then*, etc.). See Kintsch (1998, p. 60) for more examples.

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## Appendix A

### Background Questionnaire

Please print your responses to the questions below.

1. Name: \_\_\_\_\_
2. Telephone contact / e-mail contact \_\_\_\_\_
3. Year in school: Freshman    Sophomore    Junior    Senior    Other    Graduate
4. Spanish Course(s) presently taking: \_\_\_\_\_
5. Check off ALL of the Spanish courses taken at the X University, and please list other Spanish courses taken here or elsewhere:
 

SPN 101	_____	SPN 122	_____	SPN 210	_____	SPN 255	_____	_____	(others)
SPA 102	_____	SPN 123	_____	SPN 212	_____	SPN 227	_____	_____	(others)
SPN 103	_____	SPN 124	_____	SPN 214	_____	_____	(others)	_____	(others)
SPN 104	_____	SPN 200	_____	SPN 216	_____	_____	(others)	_____	(others)
6. How many **years** have you studied Spanish? (**circle one**)  
 1    2    3    4    5    6    7    8    9    10    11    \_\_\_\_\_(other)
7. Age at which you first began to learn Spanish: \_\_\_\_\_
8. Where did you first learn Spanish? \_\_\_\_\_
9. Have you studied or do you study presently any of the following languages?
 

FRENCH-	YES	NO	For how long? (mos. /yrs.)	_____
ITALIAN-	YES	NO	For how long? (mos. /yrs.)	_____
GERMAN-	YES	NO	For how long? (mos. /yrs.)	_____
OTHER	YES	NO	For how long? (mos. /yrs.)	_____

 (Please specify: \_\_\_\_\_)
10. How many languages do you speak? \_\_\_\_\_ Which languages? \_\_\_\_\_
11. Is English your native language?    YES    NO
12. Do you speak English at home?    YES    NO  
 If NO, what language do you speak at home? \_\_\_\_\_  
 If you speak other languages at home WHAT are they? \_\_\_\_\_
13. Have you EVER STUDIED ABROAD?    YES    NO  
 If YES, WHERE? \_\_\_\_\_ LENGTH OF TIME \_\_\_\_\_
14. Have you EVER spent time in a Spanish speaking country?    YES    NO

If YES, WHERE? \_\_\_\_\_ Length of stay \_\_\_\_\_  
 AGE when traveled \_\_\_\_\_ Reason for travel \_\_\_\_\_

15. Outside of class do you...

read Spanish YES / NO For what purpose? \_\_\_\_\_  
 How much per week? \_\_\_\_\_

write Spanish YES / NO For what purpose? \_\_\_\_\_  
 How much per week? \_\_\_\_\_

speak Spanish YES / NO For what purpose? \_\_\_\_\_  
 How much per week? \_\_\_\_\_ listen to

Spanish YES / NO For what purpose? \_\_\_\_\_  
 How much per week? \_\_\_\_\_

THANK YOU  
 ALL INFORMATION WILL REMAIN CONFIDENTIAL

## Appendix B

### *Sample Propositional Analysis of a More Familiar Passage—Translated English Version*

#### *The Trip to the Supermarket*

- P1 (2): realize [Sue, empty [refrigerator]]  
 P2 (1): today [P1]  
 P3 (2): get [Sue, Sue [purse]]  
 P4 (2): drive [Sue, to-supermarket]  
 P5 (1): CON (and) [P3, P4]  
 P6 (1): CON (so) [P2, P5]  
 P7 (2): park [Sue, car]  
 P8 (2): enter [Sue, supermarket]  
 P9 (1): CON (and) [P7, P8]  
 P10 (2): get [Sue, GROCERY CART]  
 P11 (1): CON (first) [P10]  
 P12 (2): take out [Sue, list, from-Sue [purse]]  
 P13 (1): CON (and) [P10, P12]  
 P14 (2): begin [Sue, walk [Sue, through-AISLES]]  
 P15 (2): go [Sue, to-canned [food [section]]]  
 P16 (1): CON (first) [P15]  
 P17 (2): want [Sue, buy [Sue, soup]]  
 P18 (1): CON (because) [P16, P17]  
 P19 (2): is [so [many [brands]]]  
 P20 (2): decide [Sue, COMPARE [Sue, prices]]  
 P21 (1): CON (that) [P19, P20]  
 P22 (2): continue [Sue, toward-fruit, vegetable [stands]]  
 P23 (2): buy [Sue, grapes]  
 P24 (1): CON (in order to) [P22, P23]  
 P25 (1): CON (then) [P18, P24]  
 P26 (2): choose [Sue, bunch]  
 P27 (1): there-at fruit-vegetable stand [P26]  
 P28 (2): go [Sue, to-bakery]  
 P29 (2): buy [Sue, bread]



P30 (1): CON (in order to) [P28, P29]  
 P31 (1): CON (afterward) [P24, P30]  
 P32 (2): greet [*Sue*, shopkeeper]  
 P33 (2): request [*Sue*, *shopkeeper*, loaf]  
 P34 (1): CON (and) [P32, P33]  
 P35 (2): continue [*Sue*, through-supermarket]  
 P36 (2): determine [*Sue*, missing [anything]]  
 P37 (1): CON (in order to) [P35, P36]  
 P38 (1): CON (then) [P30, P37]  
 P39 (2): have [*Sue*, everything]  
 P40 (2): walk [*Sue*, toward-CHECKOUT]  
 P41 (1): CON (so) [P39, P40]  
 P42 (2): many, waiting in line [people]  
 P43 (2): begin [*Sue*, read [*Sue*, TABLOIDS]]  
 P44 (1): CON (so) [P42, P43]  
 P45 (2): arrive [*Sue* [turn]]  
 P46 (1): CON (finally) [P45]  
 P47 (2): place [*Sue*, groceries, on-CHECKOUT COUNTER]  
 P48 (2): begin [salesclerk, RING UP [*salesclerk*, prices]]  
 P49 (1): CON (and) [P47, P48]  
 P50 (1): CON (so) [P46, P59]  
 P51 (2): take out [*Sue*, credit card]  
 P52 (2): pay [*Sue*, *Sue* [bill]]  
 P53 (1): CON (and) [P51, P52]  
 P54 (1): CON (afterward) [P50, P53]  
 P55 (2): get [*Sue*, BAGS]  
 P56 (2): leave [*Sue*, supermarket]  
 P57 (1): CON (and) [P55, P56]  
 P58 (1): CON (finally) [P54, P57]  
*Note.* P = Proposition. CON = sentence connective (e.g., causal, condition, purpose, concession, conjunction, and temporal). (1) = proposition worth 1 point. (2) = proposition worth 2 points. Italicized words represent argument overlap not explicitly stated in the text. Capitalized words represent the TW L1 translation equivalent.

## Appendix C

### *Parameter Estimates With Standard Errors for Measurement and Structural Models*

<u>Measurement Model: Predictor Variables</u>			$\beta$	B	SE
Reading hrs/wk <sup>†</sup>	→	Print Experience	0.86	1.00	–
Writing hrs/wk	→	Print Experience	0.85	0.90**	0.18
Speaking hrs/wk <sup>†</sup>	→	Conversation Experience	0.98	1.00	–
Listening hrs/wk	→	Conversation Experience	0.66	0.72**	0.15
Publishing	→	Passage Sight Vocabulary	0.95	1.14**	0.05
Home	→	Passage Sight Vocabulary	0.99	1.03**	0.03
Grocery <sup>†</sup>	→	Passage Sight Vocabulary	0.97	1.00	–
Doctor	→	Passage Sight Vocabulary	0.97	1.17**	0.04

Publishing	→	Passage Comprehension	0.83	0.68**	0.06
Home	→	Passage Comprehension	0.87	0.78**	0.06
Grocery <sup>†</sup>	→	Passage Comprehension	0.93	1.00	–
Doctor	→	Passage Comprehension	0.86	1.17**	0.07

Measurement Model: Vocabulary Retention Variables

			$\beta$	B	SE
Publishing-1	→	Vocabulary Retention-1	0.64	0.86**	0.20
Home-1	→	Vocabulary Retention-1	0.70	1.22**	0.28
Grocery-1 <sup>†</sup>	→	Vocabulary Retention-1	0.50	1.00	–
Doctor-1	→	Vocabulary Retention-1	0.62	0.87**	0.20
Publishing-2	→	Vocabulary Retention-2	0.63	0.99**	0.23
Home-2	→	Vocabulary Retention-2	0.74	1.37**	0.27
Grocery-2 <sup>†</sup>	→	Vocabulary Retention-2	0.54	1.00	–
Doctor-2	→	Vocabulary Retention-2	0.59	0.88**	0.22

Structural Model

			$\beta$	B	SE
Print Experience	→	Passage Sight Vocabulary	0.07	0.06	0.12
Print Experience	→	Passage Comprehension	0.04	0.03	0.08
Print Experience	→	Vocabulary Retention-1	0.18	0.60	0.50
Print Experience	→	Vocabulary Retention-2 -	0.07-	0.22	0.45
Conversation Experience	→	Passage Sight Vocabulary	0.47	0.33**	0.11
Conversation Experience	→	Passage Comprehension -	0.05-	0.03	0.08
Conversation Experience	→	Vocabulary Retention-1 -	0.21-	0.61	0.51
Conversation Experience	→	Vocabulary Retention-2 -	0.01-	0.03	0.40
Passage Sight Vocabulary	→	Passage Comprehension	0.77	0.68**	0.08
Passage Sight Vocabulary	→	Vocabulary Retention-1	0.24	0.97	0.75
Passage Sight Vocabulary	→	Vocabulary Retention-2 -	0.08-	0.32	0.60
Passage Comprehension	→	Vocabulary Retention-1	0.56	2.61**	0.84
Passage Comprehension	→	Vocabulary Retention-2	0.12	0.51	0.64
Vocabulary Retention-1	→	Vocabulary Retention-2	0.88	0.83**	0.23

Note. † = variable used to scale latent factor.  $\beta$  = standardized; B = unstandardized; SE = standard error.

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