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Is Native-Language Decoding Skill Related to Second-Language Learning?

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The authors investigated the mechanisms through which native-language word decoding ability predicted individual differences in native- and second-language learning. First, native-language decoding skill predicted college-age adults' native-language competency. However, this direct relationship was mediated by native-language vocabulary skill. Second, native-language decoding skill also predicted second-language competency. Furthermore, this relationship was mediated by participants' second-language word decoding ability. Third, native-language decoding was also an important predictor of course grade in the 1st quarter of Introductory Spanish. These results are consistent with the hypothesis that second-language learning is founded on native-language phonological–orthographic ability among college-age adults, especially during the early stages of second-language learning.

As our society becomes increasingly multilingual and learning a second language becomes more necessary, we were motivated to investigate the question: Which skills make some people faster and more efficient learners of a second language? We begin to address this question by first reviewing the current literature on children's development of their native language as this literature provides clues to the factors that may also be important to second-language learning.

Phonological Loop in Native-Language Learning

According to Baddeley, Gathercole, and Papagno (1998), the phonological-loop component of working memory (Baddeley, 1986, 1990; Baddeley & Hitch, 1974) mediates language learning by temporarily storing unfamiliar sound structures until more permanent memory representations of these novel phonological forms are constructed in long-term memory. Further, Baddeley and Hitch (1974) suggested that the phonological loop is not only involved in vocabulary development but in the acquisition of grammar skills as well. Although, to the best of our knowledge, no researchers have yet provided clear support for the latter hypothesis, the importance of the phonological loop in native-language vocabulary development has been demonstrated.

First, the work of Gathercole, Willis, and Baddeley (1991) provided convincing evidence that children's phonological-loop ability precedes and causally contributes to their vocabulary development. Four-year-old children's nonword-repetition ability, the ability to repeat aloud orally presented pseudowords accurately, served as a measure of their phonological short-term memory ability and was found to predict their native-language vocabulary skill 1 year later. By contrast, vocabulary ability at Age 4 failed to predict their nonword repetition ability at Age 5. From these findings, Gathercole et al. reasoned that phonological-loop ability precedes and predicts vocabulary development among children who are as young as 4 years old. Similar results were obtained by Gathercole and Baddeley (1989), Gathercole, Willis, Emslie, and Baddeley (1992), and Gathercole and Adams (1994). Gathercole and Baddeley (1990) generated additional evidence that phonological ability is an important contributor to the learning of novel words. They demonstrated that children with high phonological ability, as measured by the pseudoword repetition task, learned unfamiliar, made-up names of toys, such as *Sommel* and *Piemas*, more rapidly than did children with poor phonological memory skill. Additionally, children with high phonological memory ability retained the unfamiliar names of toys for a longer period of time than did children with poor phonological memories. Further, we know from a recent study by Gathercole, Service, Hitch, Adams, and Martin (1999) that children with good phonological skills differ from children with poor phonological ability specifically in how accurately they represent verbal material in their phonological working memory and not in the accuracy of their speech output.

As children grow older and experience an increase in their vocabulary knowledge, this skill itself may begin to facilitate the learning of new vocabulary terms, thus minimizing the contribution of the phonological loop. The work of Gathercole, Hitch, Service and Martin (1997), in fact, corroborates this idea: Both phonological short-term memory and existing lexical knowledge contribute to the long-term learning of phonological forms of new words among 5-year-old children. The greater one's vocabulary knowledge, the more likely a person is to find phonological approximations to the to-be-learned word in long-term memory to facilitate the learning of this word (Gathercole & Baddeley, 1993). Thus, existing vocabulary knowledge itself becomes a mediator to the learning of new vocabulary terms. However, the less word-like the unfamiliar word, the more phonological skill is thought to be required for long-term learning, as one is less likely to rely on long-term phonological and semantic knowledge to mediate the learning process.

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Phonological Loop in Second-Language Learning

First, in Service's (1992, Experiment 1) correlational research on 9-year-old Finnish children learning English as a second language, second-language phonological skill, as measured by an English pseudoword-repetition task, significantly correlated with English course grade 2.5 years later ($r = .66$, $p < .001$). Further, level of second-language vocabulary skill may also contribute to students' second-language learning, as measured by participants' course grade in English (Service & Kohonen, 1995). Cheung (1996) provided support for this idea and to the idea proposed by Gathercole et al. (1997). By administering second-language (English) phonological-loop measures (pseudoword and word span) and a second-language vocabulary task to a group of Chinese–English speaking 12-year-olds, Cheung showed that, for students with greater second-language vocabulary knowledge, phonological ability was less predictive of the speed with which they learned new English words. By contrast, there was a strong relationship between phonological ability and second-language vocabulary learning among students with lower second-language vocabulary skill. Hence, new word learning is mediated by both phonological ability and existing vocabulary knowledge. Furthermore, phonological-loop ability is a stronger predictor during the early stages of (second and native) language learning, when individuals still have few phonological approximations stored in long-term memory to facilitate the learning of novel words. Unfortunately, researchers have used only second-language (English) phonological ability measures to predict second-language learning.

Native-Language Decoding Skill in Second-Language Learning

The purpose of the present study was to investigate the role of native-language (English) nonword-decoding skill in second-language (Spanish) learning. Decoding ability is comprised of various subskills. In addition to the knowledge of speech sounds of a language (phonological skill), decoding also requires letter knowledge (orthographic skill) and the ability to map the proper sound onto the appropriate letter(s) and to blend these sounds to form an accurate phonological representation of a printed word or nonword. Hence, decoding skill is a phonological–orthographic ability.

Individuals with good phonological abilities tend to become better decoders. Cheung (1999), for example, demonstrated that as native Chinese-speaking children's second-language (English) phonological skills improved through training, so did their ability to accurately decode words in this second language. Further, we posit that good decoders are better able to construct more accurate phonological representations of unfamiliar words to then store in their short-term phonological memory (Baddeley, 1986) until more long-term phonological representations of these unfamiliar words are stored in memory (Baddeley et al., 1998). Hence, there is a clear relationship between phonological ability and decoding skill. Moreover, it is also plausible that a large vocabulary would also enhance decoding skill by increasing the number of close approximations to unfamiliar words and nonwords in memory (Gathercole & Baddeley, 1993). To the best of our knowledge, no one has investigated the predictive role of native-language decoding skill in second-language learning. Therefore, we chose to examine this question among college-age adults, for whom decoding ability would likely serve as a more appropriate predictor of second-language learning than phonological skills alone.

Our interest in learning about how second- and native-language decoding skills were related to each other led us to review the work of Sparks (1995) and Durgunoğlu, Nagy, and Hancin-Bhatt (1993). Sparks' linguistic coding differences hypothesis (LCDH) proposed that individual differences on such native-language abilities as phonological–orthographic processing (i.e., decoding), syntax, and semantic processing serve as the foundation for individual differences in second-language learning. Further, phonological–orthographic ability was thought to play a central role in the development of syntactic and semantic skills (Sparks & Ganschow, 1993). Although subtle deficiencies in native-language phonological–orthographic processing may be masked because of overexposure to one's native language, these subtle deficiencies become more pronounced as an individual begins learning a second language (Levine, 1987), hence making it more predictive of second-language learning success.

In line with the LCDH idea of native-language abilities serving as the foundation for second-language learning, Sparks, Ganschow, and Patton (1995) documented that students' English course grade in the eighth grade was one of the best predictors of their foreign-language learning success 1 year later. Further, in Sparks et al.'s (1997) article, native-language vocabulary skill was yet another predictor of participants' overall second-language proficiency. More recently, Dufva and Voeten (1999) documented that native-language phonological memory and literacy skills, such as word decoding and listening and reading-comprehension abilities, explained 58% of the variance in second-language (English) skill development.

More direct support for the LCDH, however, came from Durgunoğlu et al.'s (1993) study. Native Spanish speakers in the first grade with good phonological awareness and word-decoding ability in their native language were better at decoding words and pseudowords in their second language (English) than were those with poor native-language abilities in these areas. These findings are consistent with the cross-language transfer idea of the LCDH.

The foregoing literature motivated the following four mediational hypotheses regarding the processes involved in native- and second-language development. In line with the LCDH, we expected native-language decoding ability, as measured by pseudoword decoding accuracy, to predict participants' attainment of native-language competence, as measured by performance on the verbal subsection of the Scholastic Achievement Test (V–SAT). In addition, we expected that this relationship would be mediated by native-language vocabulary skill. Specifically, we expected that good decoders would have better vocabulary skill, which would in turn lead them to demonstrate a higher level of native-language competence. We sought to expand our knowledge of what role phonological–orthographic processing (i.e., decoding) plays in the attainment of general native-language competence and to propose a precise mechanism through which decoding skill exerts its effect on this dependent variable.

The remaining three mediational hypotheses pertain specifically to second-language learning, one for each of the three measures of second-language learning used. First, we expected that native-language pseudoword decoding ability would predict second-language vocabulary development. In light of Durgunoğlu et al.'s

(1993) findings of a cross-language transfer of word-decoding skill, we expected that this relationship between native-language decoding skill and second-language vocabulary learning would be mediated by second-language word decoding ability. More specifically, we expected that good native-language (English) decoding skill would lead to good second-language (Spanish) decoding skill, which would then facilitate the learning of second-language vocabulary. The rationale for this hypothesis is based on the theoretical explanation that a by-product of having good decoding skills is the ability to form accurate and distinct phonological representations of unfamiliar print, which can then be stored in short-term phonological memory until more long-term phonological representations are formed. Hence, good decoding skill is expected to facilitate second-language vocabulary learning.

Second, in testing Baddeley et al.'s (1998) claim that ability to store accurate and distinct phonological representations in verbal short-term memory is also involved in the acquisition of grammar, we hypothesized that native-language decoding ability would also predict performance on an abridged version of a second-language competency exam, which tests for participants' knowledge of Spanish grammar, vocabulary, and reading comprehension. We further expected that this relationship would be mediated by second-language word decoding ability, as better Spanish decoding skill would lead to the formation of more distinct phonological representations of conjugated phrases (e.g., Yo quiero, Tú quieres, Él quiere, etc.), which would consequently lead to better grammar acquisition as well. Support for this hypothesis would provide needed evidence for Sparks' (1995) hypothesis that, in addition to vocabulary acquisition, phonological–orthographic ability plays an important role in grammar acquisition as well, hence making a novel contribution to the second-language learning literature.

Lastly, we expected that good native-language decoding ability would lead to better second-language learning, as measured by participants' grade in 1 academic year of Introductory Spanish. Again, we specifically expected that this relationship would be mediated by participants' second-language word decoding ability, where good native-language decoding skill would lead to good second-language decoding, which would then help participants increase their Spanish vocabulary and grammar skills and consequently perform well in Introductory Spanish.

Support for these three mediational hypotheses would corroborate the cross-language transfer of word-decoding ability and, more important, would suggest that native-language pseudoword decoding skill is a reliable and critical predictor of individual differences in second-language learning.

Method

Participants

The participants were 80 monolingual English-speaking students enrolled in a full academic year of Introductory Spanish at University of California, Santa Barbara (UCSB). Five of the 80 participants were left handed. Their mean age was 20.7 years (range = 18 to 53, *SD* = 4.96). Each participant was compensated $20 for approximately 90 min of their time.

Design

For each participant, we recorded scores for 11 variables: native-language competency, native-language (English) pseudoword decoding accuracy, second-language (Spanish) word decoding accuracy, native-language vocabulary skill, second-language vocabulary skill, second-language competency, nonverbal intelligence, Spanish 1 course grade, Spanish 2 course grade, Spanish 3 course grade, and average Spanish course grade.

Materials and Procedure

All tasks, with the exception of the nonverbal intelligence measure and the measure of native-language vocabulary, were administered when participants were enrolled in Spanish 3. The two exceptions, however, were administered when participants were enrolled in Spanish 1. The tasks were counterbalanced, such that each task was run in each position (first, second, third, etc.) equally often. The experimental session lasted approximately 90 min. The stimuli for the native- and second-language word-decoding tasks were presented using the PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993). Each participant was run on each task individually. However, an experimenter was present for the word decoding and vocabulary tasks to record participants' responses on a response sheet.

Native-language competency. Participants' native-language competency was measured using their V–SAT scores. Sixty-five participants permitted the researchers to obtain their V–SAT scores from the Office of the Registrar of UCSB. Of the 80 participants, 5 had transferred to UCSB from various community colleges and had never taken the SAT.

Native-language pseudoword decoding. Participants' native-language decoding skill was measured using the Word Attack subtest of the Woodcock Reading Mastery Test—Revised, Form H (Woodcock, 1987). Participants were explicitly told that the pseudowords followed English pronunciation rules to discourage them from pronouncing the words with a Spanish accent. The 45 pseudowords were presented on a computer screen, one at a time, and participants had 4 s to read aloud each nonword. Experimenters, who were trained on the proper pronunciation of the pseudowords, recorded the accuracy of the participant's response on a response sheet. The number of nonwords correctly read aloud served as participants' native-language decoding skill.

Second-language word decoding. Participants' second-language decoding skill was measured using the second-language word decoding task, which was comprised of a list of 64 common Spanish words (e.g., lápiz, zanahoria) and was constructed by Marjorie Artzer, David Siebenhar, and Mark Plageman (Sparks et al., 1997). Each word was presented in the middle of a computer screen, one at a time, for a total of 4 s. Participants' responses were tape-recorded and reviewed by a single native Spanish-speaking research assistant for accuracy. The number of Spanish words read with the correct Spanish accent served as participants' second-language decoding skill.

Native-language vocabulary skill. Participants' native-language vocabulary was measured using the English version of the Boston Naming Test, a standardized test of expressive vocabulary. Participants were presented with a total of 60 line drawings, one at a time, and were asked to name each out loud. The items ranged from least difficult (e.g., bed, tree) to most difficult (e.g., yoke, stilts, abacus). Participants were given as much time as they needed to name each picture. When the participant experienced a tip-of-the-tongue state, experimenters followed up with one or both of the following two questions: "What is the first letter of the word?" and "What does the word sound like?" When a picture was named incorrectly, the experimenter transcribed the participant's incorrect response on a response sheet. The total number of pictures named correctly served as participants' native-language (English) vocabulary knowledge.

Second-language vocabulary skill. Participants' second-language vocabulary skill was measured using the Spanish version of the Boston Naming Test. The picture stimuli and procedure for this task were identical to that of the measure of native-language vocabulary skill. However, participants were instead instructed to name the pictures in Spanish.

Second-language competency. Participants' second-language competency was measured using the Spanish Questionnaire, a paper-and-pencil

task comprised of 20 multiple-choice items measuring Spanish grammar, vocabulary, and reading-comprehension ability. The verbal and grammar items were intermixed, and the reading-comprehension passage and follow-up questions appeared at the end of the test. For a sample of items measuring Spanish vocabulary, grammar, and reading comprehension skill, please see the Appendix. The questionnaire items were obtained from various old versions of Spanish placement tests, and the questionnaire was constructed with the help of the Introductory Spanish coordinator at UCSB. Participants were asked to record their answers on a scantron and were given as much time as they needed to complete the task.

Nonverbal intelligence. Participants' nonverbal intelligence was measured using the standard version of Raven's (1958) Progressive Matrices. In this paper-and-pencil measure, participants were presented with a total of 60 patterns, one at a time. Each of the 60 patterns was missing a piece, and it was the participant's task to choose one of the six to eight choices below the pattern that they believed would best complete the pattern above. Participants had as much time as they needed to complete the task. The total number of correct responses served as participants' nonverbal intelligence score. This score was then entered as a control variable in each multiple regression analysis.

Introductory Spanish course grades. All 80 participants signed a waiver granting the researcher permission to obtain their Spanish 1, 2, and 3 course grades from their Introductory Spanish instructor. Students' end-of-quarter course grade in each of the three quarters of Introductory Spanish was based on the accumulation of scores on oral and written tests as well as quizzes, in-home essay(s), and in-class participation. The quarter course grades were based on a scale ranging from *F* (0.00) to *A* (4.00).

Overall average grade in Introductory Spanish. Participants' end-of-quarter course grades in Spanish 1, 2, and 3 were averaged to obtain a single value, which represented participants' performance in the entire academic year of Introductory Spanish.

Table 1
Means and Standard Deviations of the Variables (N = 80)

Variable	*M*	*SD*	Possible range
V–SAT[a]	581.54	81.09	200–800
W–A	35.24	3.75	0–45
SLWD	33.85	6.85	0–46
BNT–E	53.68	4.19	0–60
BNT–S	6.81	4.13	0–60
SQ	13.24	2.82	0.0–20.0
RAVENS	51.59	5.51	0.0–60.0
Spanish 1	3.60	0.55	0.0–4.0
Spanish 2	2.96	0.95	0.0–4.0
Spanish 3	2.39	0.82	0.0–4.0
Average grade	2.88	0.58	0.0–4.0

Note. V–SAT = native-language competency on the verbal subsection of the Scholastic Achievement Test; W–A = native-language pseudoword decoding on the Word Attack subtest of the Woodcock Reading Mastery Test—Revised; SLWD = second-language word decoding task; BNT–E = native-language (English) vocabulary on the Boston Naming Test; BNT–S = second-language (Spanish) vocabulary on the Boston Naming Test; SQ = second-language competency on the Spanish Questionnaire; RAVENS = nonverbal intelligence on the Raven's (1958) Progressive Matrices; Spanish 1 = grade in first quarter of Introductory Spanish; Spanish 2 = grade in second quarter of Introductory Spanish; Spanish 3 = grade in third quarter of Introductory Spanish; Average grade = overall average grade in Introductory Spanish.
[a] $N = 65$.

Results

Means and standard deviations of all 11 variables are presented in Table 1, and simple correlations are summarized in Table 2. All significance tests of simple correlations were two-tailed. The mediational hypotheses below were each tested using the guidelines proposed by Baron and Kenny (1986). Furthermore, nonverbal intelligence was entered as a control variable in each regression analysis.

Hypothesis 1

In our first mediational hypothesis, we predicted that good native-language pseudoword decoding skill would lead to the attainment of higher native-language competence, as measured by performance on the V–SAT. Furthermore, we expected that this relationship would be mediated by native-language vocabulary skill. Specifically, we expected that good decoders would develop better vocabulary skills and that individuals with good vocabulary skills would then perform better on the V-SAT. A series of three regression analyses were conducted to test this hypothesis. These regression equations were analyzed using only the 65 participants for whom a complete set of data existed. The results of these analyses are summarized in Figure 1.

In the first equation, we regressed native-language competence on native-language word decoding skill. As expected, good pseudoword decoders displayed higher native-language competence, $\beta = .260$, $t(62) = 2.23$, $p < .05$. As the first criterion for a mediational model was supported, we tested whether this relationship is mediated by native-language vocabulary skill. Hence, we regressed vocabulary skill on native-language decoding ability. As expected, individuals with good native-language pseudoword decoding ability had developed better native-language vocabulary ability, $\beta = .243$, $t(77) = 2.18$, $p < .05$. In the final equation, we regressed native-language competency on native-language decoding skill and vocabulary knowledge simultaneously. As can be seen in Figure 1, individuals with better native-language vocabulary knowledge displayed a higher level of native-language competence, $\beta = .485$, $t(61) = 4.69$, $p < .001$. Moreover, the association between native-language decoding skill and native-language competence was considerably reduced and was no longer statistically significant when participants' vocabulary knowledge was entered into the equation, $\beta = .129$, $t(61) = 1.24$, $p > .05$. In sum, our results are consistent with a mediational hypothesis that good native-language decoders are more likely to attain greater native-language competence in part because they have acquired greater native-language vocabulary skill.

The next three mediational hypotheses pertain specifically to predicting individual differences in second-language learning, as measured by (a) second-language vocabulary knowledge, (b) second-language grammar ability, and (c) grade in Spanish 1.

Hypothesis 2

We hypothesized that individuals with better native-language pseudoword decoding skill would be more likely to develop greater second-language vocabulary knowledge. Furthermore, we expected that this relationship would be mediated by second-language word decoding ability. Specifically, we hypothesized that better native-language decoding leads to greater second-language vocabulary ability because better native-language decoders tend to also be better second-language decoders, which helps these indi-

Table 2
Intercorrelations of the Variables (N = 80)

Variable	1	2	3	4	5	6	7	8	9	10	11
1. V–SAT	—										
2. W–A	.37**	—									
3. SLWD	.48***	.53***	—								
4. BNT–E	.60***	.28*	.21	—							
5. BNT–S	.36**	.34**	.37**	.14	—						
6. SQ	.47***	.39***	.52***	.21	.14	—					
7. RAVENS	.43***	.26*	.27*	.22	.10	.13	—				
8. Spanish 1	.34**	.25*	.46***	.04	.16	.52***	.00	—			
9. Spanish 2	.21*	−.07	.11	.16	−.01	.18	.15	.23*	—		
10. Spanish 3	−.04	.02	.12	−.03	−.13	.30**	−.01	.41***	.22	—	
11. Average grade	.29*	.07	.35**	.09	−.01	.37**	.20	.54***	.59***	.64***	—

Note. V–SAT = native-language competency on the verbal subsection of the Scholastic Achievement Test; W–A = native-language pseudoword decoding on the Word Attack subtest of the Woodcock Reading Mastery Test—Revised; SLWD = second-language word decoding task; BNT–E = native-language (English) vocabulary on the Boston Naming Test; BNT–S = second-language (Spanish) vocabulary on the Boston Naming Test; SQ = second-language competency on the Spanish Questionnaire; RAVENS = nonverbal intelligence on the Raven's (1958) Progressive Matrices; Spanish 1 = grade in first quarter of Introductory Spanish; Spanish 2 = grade in second quarter of Introductory Spanish; Spanish 3 = grade in third quarter of Introductory Spanish; Average grade = overall average grade in Introductory Spanish.
* $p < .05$. ** $p < .01$. *** $p < .001$.

viduals form long-term phonological representations of foreign-language words more easily. The results of these regression analyses are summarized in Figure 2.

First, we regressed second-language vocabulary knowledge on native-language pseudoword reading ability. As we expected, individuals with better native-language pseudoword decoding ability had greater second-language vocabulary knowledge, $\beta = .332$, $t(77) = 2.99$, $p < .01$. Given that we had met the first criterion for a mediational model, we proceeded to test whether this relationship is mediated by second-language word decoding ability. As expected, individuals with good native-language pseudoword decoding skill were better word decoders in their second language, $\beta = .490$, $t(77) = 4.96$, $p < .001$. Finally, as we see in Figure 2, individuals with good second-language decoding ability had greater knowledge of second-language vocabulary, $\beta = .272$, $t(76) = 2.17$, $p < .05$. Furthermore, the association between native-language pseudoword decoding ability and second-language vocabulary knowledge diminished considerably and was no longer statistically significant when second-language word decoding ability was entered into the equation, $\beta = .199$, $t(76) = 1.60$, $p > .05$. These findings are consistent with the hypothesis that individuals

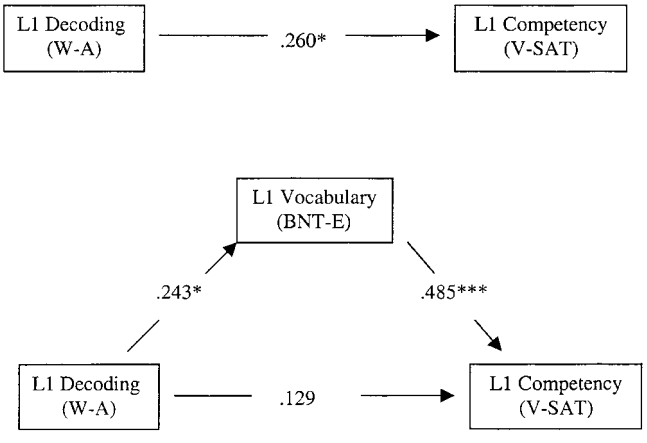

Figure 1. Regression analyses testing the hypothesis that native-language vocabulary skill (L1 Vocabulary) mediates the relationship between native-language pseudoword decoding ability (L1 Decoding) and native-language competency (L1 Competency), as measured by verbal Scholastic Achievement Test (V–SAT) scores. General intelligence was entered as a control variable in each regression analysis. Values shown are standardized regression coefficients. W–A = Word Attack subtest of the Woodcock Reading Mastery Test—Revised; BNT–E = English version of the Boston Naming Test. * $p < .05$. *** $p < .001$.

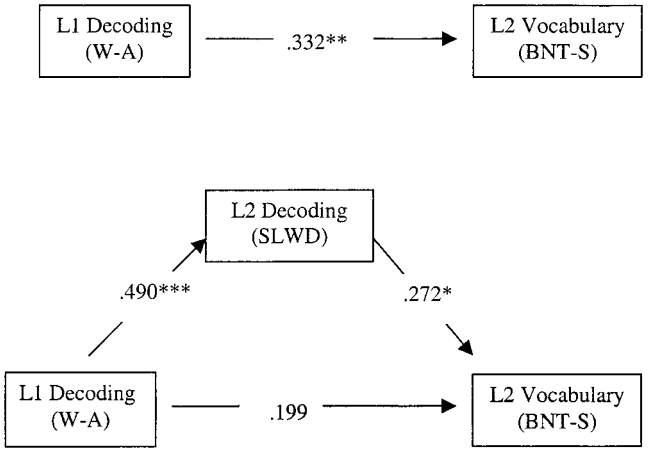

Figure 2. Regression analyses testing the hypothesis that second-language word decoding ability (L2 Decoding) mediates the relationship between native-language pseudoword decoding (L1 Decoding) and second-language vocabulary skill (L2 Vocabulary). General intelligence was entered as a control variable in each regression analysis. Values shown are standardized regression coefficients. W–A = Word Attack subtest of the Woodcock Reading Mastery Test—Revised; BNT–S = Spanish version of the Boston Naming Test; SLWD = second-language word decoding task. * $p < .05$. ** $p < .01$. *** $p < .001$.

with good native-language decoding ability develop greater vocabulary knowledge in their second language in large part because they have better decoding ability in their second language, which enables these individuals to construct and consequently store accurate phonological representations of foreign-language words in long-term memory more easily.

Hypothesis 3

Our third mediational hypothesis predicted that individuals with good native-language pseudoword decoding skill are more likely to have attained greater general competence in their second language, as measured by an abridged second-language competency exam measuring knowledge of Spanish grammar, vocabulary, and reading comprehension. Moreover, we expected that this relationship would be mediated by second-language word decoding skill. The results of the regression analyses that we conducted to test this mediational hypothesis are summarized in Figure 3.

First, as expected, good native-language pseudoword decoding skill did lead to better performance on the second-language competency test, $\beta = .385$, $t(77) = 3.54$, $p < .01$. Having met the first criterion of Baron and Kenny's (1986) guidelines, we proceeded to test whether this relationship was mediated by individuals' second-language word decoding ability. From the test of the second mediational hypothesis above, we have already established that native-language pseudoword decoding ability predicts second-language word decoding ability (our proposed mediator). Looking at Figure 3, we see that individuals with good second-language word decoding ability attained better scores on the second-language competency test, $\beta = .435$, $t(76) = 3.76$, $p < .001$.

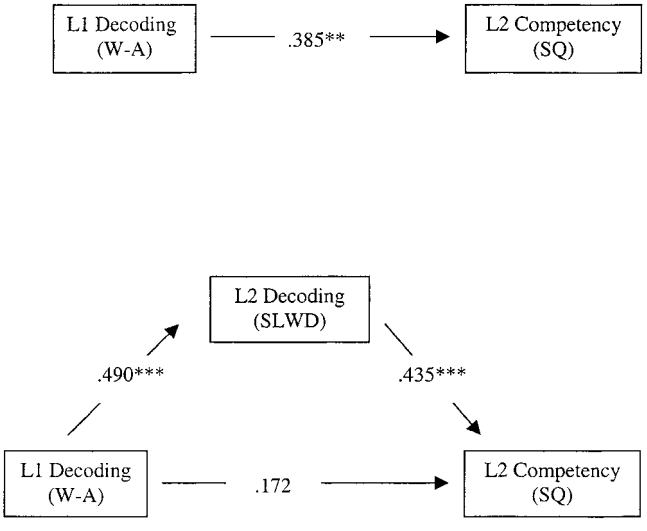

Figure 3. Regression analyses testing the hypothesis that second-language word decoding ability (L2 Decoding) mediates the relationship between native-language pseudoword decoding (L1 Decoding) and second-language competency (L2 Competency), as measured by the Spanish Questionnaire (SQ). General intelligence was entered as a control variable in each regression analysis. Values shown are standardized regression coefficients. W–A = Word Attack subtest of the Woodcock Reading Mastery Test—Revised; SLWD = second-language word decoding task. ** $p < .01$. *** $p < .001$.

Furthermore, the relationship between native-language pseudoword decoding ability and second-language competency was substantially reduced and was no longer statistically significant when second-language word decoding ability was entered in the equation, $\beta = .172$, $t(76) = 1.49$, $p > .05$. In sum, these results are consistent with the hypothesis that good native-language pseudoword decoders are more likely to acquire greater second-language competence, as measured by knowledge of Spanish grammar, vocabulary, and reading comprehension, because these individuals tend to also develop better second-language word decoding ability, which enables them to convert second-language print into sounds in a more accurate manner. Storing an accurate and distinct phonological representation of second-language words and word phrases in short-term verbal memory consequently facilitates the long-term learning of the second language.

Lastly, in looking at the simple correlations in Table 2, we see that the expected relationship between native-language word decoding ability and average course grade in Introductory Spanish was not statistically significant ($r = .08$, $n = 76$). However, we see that the relationship between native-language decoding skill and participants' course grade in Spanish 1, a component of average Spanish course grade, was indeed significant ($r = .25$, $n = 80$, $p < .05$). Therefore, we proceeded to test our mediational hypothesis using Spanish 1 course grade as the dependent variable.

Hypothesis 4

As anticipated, individuals with better native-language pseudoword decoding ability had earned higher grades in Spanish 1, the first quarter of Introductory Spanish, $\beta = .267$, $t(77) = 2.34$, $p < .05$. Having met the first criterion of a mediational hypothesis, we wanted to see if this relationship was mediated by second-language word decoding ability. Having already established that native-language decoding ability predicts second-language decoding ability, we advanced to our final regression analysis, in which we regressed Spanish 1 course grade on both native-language and second-language decoding ability simultaneously. These last two criteria of a mediational hypothesis were also met (see Figure 4). Specifically, individuals with better second-language decoding ability performed better in the first quarter of Introductory Spanish, $\beta = .486$, $t(76) = 4.04$, $p < .001$. Furthermore, the relationship between native-language pseudoword decoding skill and Spanish 1 course grade was weakened substantially and was no longer statistically significant when second-language decoding skill, our proposed mediator, was simultaneously entered into the regression equation, $\beta = .029$, $t(76) = .24$, $p > .05$. Native-language pseudoword decoding ability helps individuals perform better in their first quarter of Introductory Spanish largely because native-language decoding skill predicts second-language word decoding ability, which in turn facilitates second-language learning.

Discussion

In light of the somewhat distinct literature that exists on native-language and second-language acquisition, we have organized the discussion of our results into two subsections: (a) native-language development and (b) second-language development.

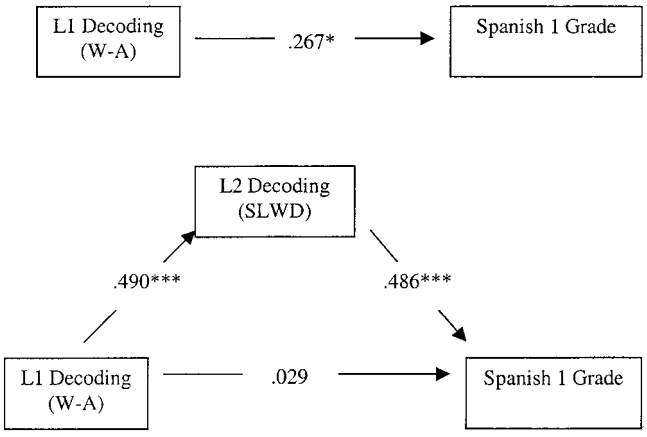

Figure 4. Regression analyses testing the hypothesis that second-language word decoding ability (L2 Decoding) mediates the relationship between native-language pseudoword decoding (L1 Decoding) and Spanish 1 course grade. General intelligence was entered as a control variable in each regression analysis. Values shown are standardized regression coefficients. W–A = Word Attack subtest of the Woodcock Reading Mastery Test—Revised; SLWD = second-language word decoding task. * $p < .05$. *** $p < .001$.

Native-Language Development

Good nonword decoders tended to have greater vocabulary skill, which in turn enabled native-language ability. This mediational model was supported even when participants' general intelligence was controlled. In sum, native-language phonological–orthographic ability predicts higher level language abilities through its direct effect on native-language vocabulary development. Good decoders are able to accurately convert print into sound, and as Baddeley et al. (1998) asserted, an accurate and distinct phonological representation stored in the short-term verbal memory is important for long-term learning of verbal material to occur.

Second-Language Development

Native-language phonological–orthographic ability may also be an important predictor of second-language learning, as measured by a second-language vocabulary task (Hypothesis 2); a second-language competency task, measuring Spanish vocabulary, grammar, and reading skills (Hypothesis 3); and Spanish 1 course grade (Hypothesis 4). In Service (1992) and Cheung (1996), phonological ability was an important predictor of second-language learning, as measured by second-language course grade and speed of second-language vocabulary learning, respectively. In both studies, second-language phonological ability predicted second-language learning. In the study reported here, phonological–orthographic skill, specifically native-language decoding skill, also served as a predictor of second-language learning among college-age adults.

First, even when participants' general intelligence level was controlled, native-language nonword decoding ability was still a good predictor of second-language competency, as measured by participants' knowledge of Spanish vocabulary, grammar, and reading-comprehension skills. Good pseudoword decoders have the ability to represent the phonological structures of unfamiliar words and word phrases more accurately and distinctly than poor decoders. Following the reasoning of Baddeley et al. (1998), this ability enables good decoders to form long-term phonological representations of unfamiliar sound forms more easily and quickly. Thus, individuals with good native-language phonological–orthographic ability are advantaged when learning a second language.

There was an important role of native-language pseudoword decoding in the course grade obtained in the first quarter of Introductory Spanish (Hypothesis 4). That the criteria for a mediational hypothesis were met when we used Spanish 1 course grade as the dependent variable but not when we used average Spanish course grade as the dependent variable is noteworthy. Phonological–orthographic ability probably plays a particularly important role during the early stages of second-language learning, when individuals have relatively little or no knowledge of their second language and consequently have few close approximations to second-language words stored in their long-term memory to mediate the learning of the second language.

We expected that any effect of decoding ability on more advanced stages of second-language learning (e.g., Spanish 2 and 3) would be mediated by second-language vocabulary development (Hypothesis 1). Had we used a more sensitive measure of participants' second-language vocabulary knowledge, we might have observed a mediational process similar to the one observed for participants' native-language abilities (see Figure 1). Specifically, second-language word decoding ability should predict participants' average grade in Introductory Spanish through its direct effect on second-language vocabulary development. If this mediational process is confirmed by a future study, then decoding ability is indeed a good predictor of vocabulary ability, and vocabulary ability itself is a critical building block on which higher level language abilities, such as reading comprehension, are based.

In this study, phonological–orthographic ability was an important predictor of second-language learning ability in adulthood. In line with Cheung's (1996) rationale; perhaps phonological–orthographic ability will continue to be an important predictor of language learning as long as the learner has relatively little knowledge of the target language. Hence, the importance of phonological–orthographic ability in language learning may be less dependent on the age of the learner and more dependent on how much long-term knowledge in the target language the second-language learner possesses.

Lastly, in support of Durgunoğlu et al.'s (1993) findings, there was a clear cross-language transfer of decoding ability from participants' native language to their second language. The mechanism through which native-language phonological–orthographic ability influenced second-language learning was through its effect on second-language word decoding ability. Further, consistent with the LCDH (Sparks, 1995), we obtained evidence that second-language learning is founded on native-language phonological–orthographic ability.

Native-language pseudoword decoding ability is a potentially important predictor of individual differences in both native- and second-language development. As our mediational models were based on correlations, however, we must follow them up with experimental studies to have more confidence in the results. An important follow-up study that would help would be to investigate

whether native-language decoding training enhances individuals' second-language learning success and to see if it would do so by specifically increasing participants' second-language word decoding ability. If it is so, then native-language decoding ability's relationship to second-language learning would indeed seem to be causal in nature, consistent with evidence that direct training in the sound–symbol relationships of the native language does transfer over and facilitate second-language learning (Ganschow & Sparks, 1995; Sparks et al., 1998; Sparks, Ganschow, Artzer, & Patton, 1997; Sparks, Ganschow, Kenneweg, & Miller, 1991). Hence, we leave open the possibility that decoding ability in the native language is an important predictor of second-language learning, particularly during the early stages of second-language study.

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(*Appendix follows*)

Appendix

Second-Language Competency Test Sample Items

Vocabulary

1. Era una noche oscura sin _____.
   A. nubes B. estrellas C. lágrimas D. camas
2. Tienes much trabajo. Queremos _____.
   A. ayudarte B. empujarte C. llevarte D. castigarte

Grammar

1. Pedro y yo siempre _____ juntos.
   A. comer B. como C. coman D. comemos
2. Quiso saber la hora y por eso Juan _____ el reloj.
   A. miraron B. mira C. miró D. mire

Reading Comprehension

¡Era Nochebuena! En casa de los Gonzáles, Pablo y Marta se reunían con su familia para hacer el Nacimiento. Pablo quería colocarlo en la ventana para que todos los vecinos al pasar tuvieran la oportunidad de mirarlo. Por su parte, Marta deseaba arreglar el establo y las figuras en una mesa cerca de la chimenea en donde se pudieran poner los regalos que les iba a traer el Nino. Despues de la discusión, es la mamá quien resuelve el problema. Ella les propone que arreglen el Nacimiento y la mesa en un lugar entre la ventana y la chimenea. Al ver esta solución tan sencilla toda la familia se ríe.

1. Es evidente que Pablo y su hermana _____.
   A. tienen que ir a la calle B. tienen que reunirse con sus vecinos
   C. van a recibir regalos muy pronto D. van a desobedecer a su madre
2. La mamá de la familia es buena porque _____.
   A. se enfada al escuchar a sus hijos B. recibe regalos de sus hijos
   C. ignora lo que pasa D. comprende los problemas de sus niños

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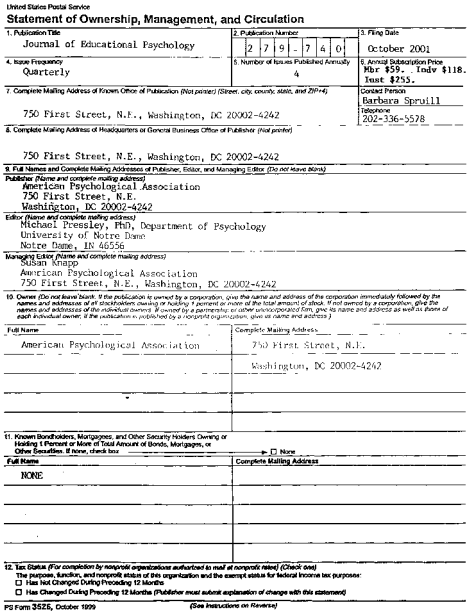

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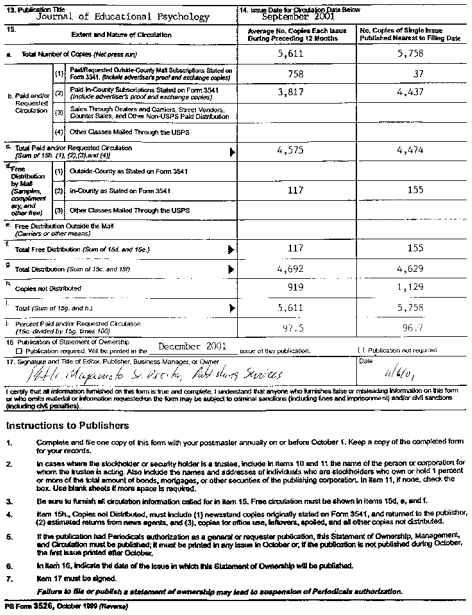

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