

Cognitive Factors in Second-Language Acquisition and Literacy Learning

A Theoretical Proposal and Call for Research

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The question of which factors facilitate and expedite the acquisition of a second language (L2) is of both practical and theoretical importance. Individuals who attain a good command of oral skills (listening and speech production) and written skills (reading and writing) in an L2 are at an advantage. They can compete with native speakers more successfully at school and at work, thereby increasing their chances of securing a higher standard of living. As the number of public school students from non-English-speaking homes increases in the United States, the importance of understanding those factors that facilitate the learning of an L2 becomes paramount.

Our purpose in this chapter is to review selected cognitive factors that facilitate L2 learning. (For a complementary discussion of sociocultural and institutional factors, see Zecker, Chapter 12, this volume.) Identifying predictors of quality L2 acquisition enables us to understand how language is organized in general, and it provides testable hypotheses for how L2 acquisition may be improved. We view our chapter as a proposal for a new way to think about L2 acquisi-

tion issues, and we hope that it encourages new research in this domain.

This chapter addresses four main issues. First, we define a key concept, namely, phonological ability. Second, we discuss selected cognitive abilities that facilitate native-language and L2 acquisition. Third, we present data concerning the relationship between L2 learning and native language abilities. Finally, we conclude with a brief discussion of the presented behavioral evidence and propose future research directions that can further contribute to our knowledge of individual differences in L2 learning.

WHAT IS PHONOLOGICAL ABILITY?

Before presenting the literature on native- and L2 development, we first define a term that appears frequently throughout this chapter, namely, "phonological ability." We use the term to refer to an individual's ability to perceive accurately and represent novel speech sounds, such as L2 words and phrases. This includes being sensitive to where in

the spoken L2 word stresses are placed so as to represent the unfamiliar word with the proper accent. Furthermore, it also includes possessing sensitivity to the individual sound units (phonemes) that comprise an unfamiliar spoken word. This latter sensitivity, which relates to Brady's (1997) notion of speech perception, can manifest itself in one's ability to detect accurately differences between similar-sounding phonemes, such as detecting the difference in the "ea" sound in the words *year* and *yearn*. Hence, by phonological ability, we refer to the ability not only to represent a word with the proper accent, but also to perceive accurately the individual sound units that comprise the unfamiliar spoken word.

Although it may be considered a controversial point, we expect that this sensitivity to novel speech sounds is partly what discriminates individuals who have an easy time learning an L2 from those who find this task arduous and unpleasant. Of course, other factors, such as the motivation to learn the L2, the attitude toward the L2 (Gardner, 1985), and the instructional design for learning or acquiring the L2 (Bus & van IJzendoorn, 1999) all make their own important contributions to the learning process (see Zecker, Chapter 12, this volume). However, this chapter focuses mainly on the cognitive factors implicated in L2 learning.

The phonological ability construct is related to two concepts that appear in the developmental literature, namely, phonological awareness and phonological working memory. The term "phonological awareness" appears in the reading development literature. It refers to one's awareness that spoken words comprise individual sound units, and that these sound units can be manipulated. This awareness is thought to precede early reading abilities (Perfetti, Beck, Bell, & Hughes, 1987; Wagner & Torgesen, 1987).

The term "phonological working memory" is used in the native-language development literature and is derived from Baddeley's (1986) model of working memory. According to Baddeley's model, phonological working memory, specifically, the phonological loop component that compris-

es it, mediates language learning by providing temporary storage of unfamiliar sound forms until more permanent representations are constructed in long-term memory (Baddeley, Gathercole, & Papagno, 1998). The idea is that the ability to construct accurate and distinct short-term phonological representations of unfamiliar speech sounds predicts vocabulary learning.

Although the term "phonological ability" does share similarity with "phonological awareness" and "phonological working memory," our purpose in this chapter is to emphasize the importance of forming accurate sound representations of unfamiliar words and phrases. This point does not receive sufficient emphasis in the research on phonological awareness and phonological working memory.

Phonological ability underlies both phonological awareness and phonological working memory, and it is an important component of these two constructs. However, phonological awareness and phonological working memory require that additional manipulations be performed on the accurate phonological representations that have been formed. These manipulations include the maintenance of phonological information through rehearsal (in phonological working memory) and segmenting, blending, and phoneme deletion (in phonological awareness). Given that the ability to carry out these latter processes (i.e., segmenting, blending, and phoneme deletion) requires the temporary maintenance of a target phonological representation in phonological working memory, it follows that phonological awareness and phonological working memory also relate to each other (for review, see Gathercole & Baddeley, 1993a).

Because the ability to form accurate phonological representations is an important component of phonological awareness and phonological working memory, we next present research that has used these two constructs. However, in reviewing these studies, we acknowledge that these constructs also involve additional processes. Nevertheless, we believe they possess sufficient overlap with phonological ability to warrant the review of studies that have employed them.

THE ROLE OF PHONOLOGICAL ABILITY IN NATIVE- AND SECOND-LANGUAGE DEVELOPMENT

In this section, we review literature that implicates accurate phonological representations in native-language and L2 development. The first two subsections present evidence to suggest that phonological ability plays an important predictive role in native-language vocabulary and reading comprehension development, respectively. The latter two subsections review the role of phonological ability in L2 vocabulary and reading comprehension development, respectively.

Accurate Phonological Representations in Native-Language Vocabulary Development

A number of research findings suggest that the ability to store accurate phonological representations of new words in phonological working memory plays a causal role in the development of native-language vocabulary. Gathercole, Willis, Emslie, and Baddeley (1992) used the pseudoword (pronounceable nonword) repetition task as a measure of phonological working memory, in which the participant is asked to repeat aloud accurately an auditorily presented pseudoword. These authors found that the ability of 4-year-old children to repeat pseudowords aloud accurately predicted their native-language vocabulary knowledge 1 year later, at age 5 years. However, vocabulary knowledge at age 4 years was not a significant predictor of pseudoword repetition accuracy at age 5. The authors reasoned that this pattern of correlations suggests that phonological working memory is a preceding condition that causally predicts quality of vocabulary development in the native language. Because they measured phonological working memory using the pseudoword repetition task, which is a good way to measure an individual's ability to represent novel speech sounds accurately, their findings suggest that individuals who are able to form accurate phonological representations of novel sound forms are advantaged in learning new words. Furthermore, work by Gathercole, Service, Hitch, Adams, and Martin (1999) indicates

that children with good phonological ability differ from those with poor phonological ability in how accurately they represent verbal material in their phonological working memory; however, they do not differ in the accuracy of their articulation.

Gathercole and Baddeley (1990) provide further indirect evidence of the role of phonological ability in learning new words. They controlled for nonverbal intelligence and showed that children with high phonological working memory, as measured by the pseudoword repetition task, learned unfamiliar, made-up toy names (e.g., *Sommel* and *Piemas*) more rapidly than did children with poor phonological working memory abilities. Furthermore, children with high phonological working memory retained the novel toy names for a longer period of time than did the children with poor phonological working memory.

Additional research that is more experimental in nature has provided evidence that disrupting the quality of the temporary phonological representations stored in phonological working memory leads to impaired long-term learning of the sound forms of new words (for review, see Baddeley et al., 1998; Gathercole & Baddeley, 1993b). For example, Papagno, Valentine, and Baddeley (1991) showed that requiring healthy Italian adults to repeat aloud an irrelevant word during a paired-associate learning task disrupted the learning of novel foreign-language (Russian) words, but not of familiar, native-Italian words. The repetition of an irrelevant sound out loud, which is an articulatory suppression condition, is believed to prevent the rehearsal of the novel sound forms that are temporarily stored in phonological working memory. Hence, the item decays when its short-term phonological representation cannot be refreshed through rehearsal. The absence of accurate and distinct short-term phonological representations of unfamiliar L2 words thus prevents long-term learning.

Once children construct more long-term phonological and semantic representations, vocabulary knowledge itself begins to mediate the learning of new words. Gathercole et al. (1992) demonstrated that, over age 5 years, phonological working memory no

longer predicted new vocabulary acquisition. Rather, they found that, by that age, existing vocabulary knowledge itself began to mediate the learning of new vocabulary. Similar conclusions have also been made by Gathercole (1995), Gathercole, Hitch, Service, and Martin (1997), and Cheung (1996).

These results suggest that good phonological abilities precede and causally facilitate vocabulary development in one's native language. Once sufficient vocabulary knowledge has been developed, vocabulary size itself replaces phonological ability as the predictor of learning new words. (For further discussion on word learning, see McGregor, Chapter 14, this volume.)

Vocabulary knowledge will predict new-word learning as long as individuals possess sufficient long-term knowledge of their target language. However, when individuals have minimal knowledge of their target language (e.g., when beginning to learn an L2), we expect that phonological abilities will be more heavily taxed and, consequently, serve as a stronger predictor of language development.

In summary, we believe that good phonological ability predicts language competency (e.g., listening and reading comprehension, speech production) in a target language as a result of its direct effect on vocabulary development. Hence, there is ample evidence to suggest that vocabulary knowledge mediates the direct relationship between phonological ability and language competency.

Accurate Phonological Representations in Native-Language Reading Development

Individuals with good phonological awareness are more advantaged when developing early reading abilities, such as individual-word or pseudoword decoding (Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Durgunoglu & Oney, 2002; Holopainen, Ahonen, Tolvanen, & Lyytinen, 2000; Perfetti et al., 1987). Decoding is the ability to convert a printed word or nonword accurately into sound. Individuals who are aware that spoken words are made up of smaller units of sound (phonemes) are more likely to understand that written words, too, are

made up of smaller units (graphemes) that correspond to individual sounds. Hence, individuals who have an accurate phonological representation of words and can successfully manipulate (e.g., blend, segment) these representations are expected to have an easier time cracking the alphabetic code and reading individual words in an accurate manner.

For example, Perfetti et al. (1987) showed that the ability to blend individual sound units to form words or pseudowords plays a unidirectional, facilitating role in children's early reading development. Holopainen et al. (2000) also showed that a model emphasizing phonological awareness as a prerequisite for learning to read individual words fit their observed data better than did an alternative model that specified individual word-reading ability as a predictor of phonological awareness development.

Moreover, multiple regression analyses of longitudinal data have also shown a direct, predictive relationship between phonological awareness and reading comprehension ability in participants' native language. For example, Demont and Gombert (1996) showed that phonological awareness skills, such as syllable counting and final phoneme deletion, measured at the beginning of grade 1, explained 23% and 18%, respectively, of the variance in end-of-grade-2 reading comprehension, both before and after entering nonverbal intelligence and vocabulary knowledge into the regression equation. Furthermore, multiple regression analyses of longitudinal data (Juel, Griffith, & Gough, 1986) also revealed that, even when entered after IQ, vocabulary, and listening comprehension, phonological awareness still explained approximately 24% ($p < .01$) of the unique variance in grade-1 reading comprehension and 17% ($p < .01$) of the unique variance in grade-2 reading comprehension. Others (e.g., Gottardo, Stanovich, & Siegel, 1996; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997) also found that phonological awareness still predicted native-language reading comprehension, albeit less strongly, when it was entered into the regression equation after other relevant variables. Finally, a longitudinal study by Gathercole and Baddeley

(1993a) showed that the ability to form accurate phonological representations of novel sound forms plays an important causal role in both vocabulary and reading development. Specifically, they showed that nonword repetition accuracy in children at age 4 years explained 10% of the variance in vocabulary knowledge and 9% of the variance in reading comprehension 4 years later, when the children were 8 years old. Although the evidence is compelling, more caution in the interpretation of the results may be required because of the correlational nature of these findings (see also Scott, Chapter 16, and Donahue, Chapter 17, this volume, for other linguistic factors contributing to reading comprehension).

Accurate Phonological Representations in Second-Language Vocabulary Development

As indicated in the preceding section, the ability to repeat aloud unfamiliar sound forms (e.g., pronounceable nonwords) accurately has been consistently found to predict native language learning. Therefore, it is feasible that this ability can also play a predictive role in L2 learning. In fact, several researchers have implicated good phonological or phonological-orthographic abilities in L2 learning success. For example, Service (1992) found that the ability of 9-year-old Finnish children to repeat aloud pronounceable nonwords accurately in English (L2) predicted their English course grade, as well as their English reading and writing abilities. Service reasoned that many of the abilities that enable a student to perform well in an English (L2) course, such as listening and reading comprehension, are founded on good knowledge of English vocabulary. She concluded that the ability to represent accurately the sounds of the L2 must facilitate L2 vocabulary development, which is important for higher level L2 cognitive abilities (e.g., L2 reading and listening comprehension). In their later work, Service and Kohonen (1995) conducted fixed-order multiple regression analyses to show that English (L2) nonword repetition ability no longer predicted English proficiency when they controlled for English vocabulary

knowledge. These results again suggested that L2 vocabulary is necessary for higher level L2 cognitive abilities, and that once students have developed sufficient L2 vocabulary knowledge, phonological ability in the L2 loses its predictive ability.

Cheung (1996) showed that phonological ability is a good predictor of the speed of L2 (English) vocabulary learning in native-Chinese-speaking seventh graders. In addition, he also found that this predictive relationship existed only for students whose vocabulary knowledge in their L2 was below the group median. Hence, there is consistent evidence that long-term semantic and phonological information, as represented by vocabulary knowledge, interacts with the representations in short-term phonological memory to mediate language development.

More recent work by Sparks and colleagues (Sparks & Ganschow, 1991, 1993; Sparks, Ganschow, & Javorsky, 1992; Sparks, Ganschow, & Pohlman, 1989) and Meschyan and Hernandez (2002) lends support to the relationship between accurate phonological representations and L2 learning. Sparks and colleagues found that high-school students with phonological deficiencies experienced difficulty during the early stages L2 learning. Meschyan and Hernandez (2002), working with English-speaking college students, also found that a measure of phonological-orthographic ability (pseudoword decoding) predicted students' course grades in their L2 (Spanish) for the first quarter of L2 instruction, but not for the second or third quarter. They concluded that phonological-orthographic ability exerts its effect during the early stages of L2 learning, when minimal long-term knowledge of the L2 exists to mediate L2 learning.

When knowledge of L2 phonology is limited, the ability to represent the speech sounds of the target language accurately is a preexisting ability that can facilitate and expedite L2 acquisition. Good phonological ability is a facilitator of higher level L2 abilities, such as vocabulary knowledge and reading comprehension. Individuals with below-average phonological abilities are not prevented from learning an L2; however, their journey to L2 learning may be longer

and more arduous, requiring more exposures to the novel language before long-term learning takes place (Cheung, 1996). As the process becomes more difficult, the danger of losing the motivation to learn the L2 increases. Hence, individuals with poor phonological abilities can become less invested in learning the L2 (Ganschow, Sparks, & Javorsky, 1998).

Accurate Phonological Representations in Second-Language Reading Development

In a recent study, Meschyan (2002) also investigated the nature of the direct relationship between phonological ability and reading comprehension, a relationship that has been consistently demonstrated in the native-language literature. However, Meschyan investigated this relationship in the L2 domain, with Spanish-speaking children in grades 4 and 5, who were learning English as an L2. Meschyan pitted two models against each other.

Model A hypothesized that the direct relationship between English (L2) phonological awareness and English (L2) reading comprehension was mediated by English decoding accuracy and English vocabulary knowledge. Good L2 phonological awareness was expected to predict good L2 decoding ability. Furthermore, good L2 decoding was hypothesized to predict good L2 reading comprehension directly and indirectly, by facilitating L2 vocabulary knowledge development (Meschyan & Hernandez, 2002). L2 vocabulary knowledge itself was, in turn, expected to predict L2 reading comprehension directly.

In contrast, Model B hypothesized that English (L2) vocabulary knowledge is the preceding ability that predicts L2 reading comprehension through its direct positive effects on L2 phonological awareness and L2 decoding accuracy. Hence, in Model B, L2 vocabulary knowledge served as the primary predictor of L2 reading comprehension, whereas L2 phonological awareness and L2 decoding were treated as the mediator variables.

The findings showed that Model A fit the observed data slightly better and more parsimoniously than the alternative Model B.

This suggests that possessing accurate phonological representations of L2 words, and the ability to manipulate these representations, is an ability that precedes and promotes higher level reading comprehension ability indirectly, through its direct and positive effects on L2 decoding accuracy. Accuracy in L2 decoding can then directly improve L2 reading comprehension. In addition, L2 decoding can also improve L2 reading comprehension indirectly by facilitating good L2 vocabulary knowledge. However, in light of the correlational nature of these results, some caution in their interpretation is warranted.

In summary, these studies suggest that the ability to form accurate phonological representations of unfamiliar L2 words may play a facilitating role in L2 vocabulary development and reading ability. An implication is that L2 learners who have below-average or even slight deficiencies in their L2 phonological or phonological-orthographic abilities can benefit from explicit instruction in the accurate representations of spoken or written L2 words.

Summary

In this section, we have presented evidence suggesting that the ability to form accurate phonological representations of unfamiliar words precedes and plays an important predictive role in native-language vocabulary and reading comprehension development. We have also presented evidence that suggests this ability also predicts vocabulary and reading comprehension abilities in an L2.

SECOND-LANGUAGE LEARNING AND NATIVE-LANGUAGE ABILITY: WHAT IS THE RELATIONSHIP?

Does L2 learning relate to native-language abilities, or does it develop relatively independently? In this section, we present selected findings on the relationship between L2 learning and native-language abilities. We conclude with a suggestion regarding what the presented evidence implies about the linguistic processes that subserve native- and

L2 phonological and phonological-orthographic abilities.

According to the linguistic coding differences hypothesis (LCDH; for review, see Sparks, 1995), L2 acquisition is founded on native-language abilities in the areas of phonological, syntactic, and semantic processing. However, of these three language codes, the one that is most consistently implicated in L2 learning problems is phonological or phonological-orthographic ability. Just as phonological processing deficiencies have been implicated in problems of reading development (Stanovich, 1988), poor phonological abilities have also been implicated in L2 learning. Our recent work with English-speaking college students (Meschyan & Hernandez, 2002) has provided strong and direct support for the LCDH. If poor native-language phonological-orthographic ability predicts poor L2 phonological-orthographic ability, then this would suggest that this ability is based on linguistic processes that are not specific to any particular language. Therefore, native language decoding ability should be a good indicator of L2 decoding ability. Furthermore, if the ability to convert printed words accurately into sound facilitates language development, as the LCDH suggests, then we would also expect that good phonological-orthographic ability in the native language would transfer to the L2 and facilitate L2 learning. In fact, this is what we found.

Meschyan and Hernandez (2002) showed that college students' native language (English) pseudoword decoding predicted their L2 (Spanish) learning by its direct effect on Spanish word-decoding ability. Individuals who were better at decoding pseudowords in English were also better at decoding words in their L2, Spanish. This good phonological-orthographic ability in participants' L2 in turn predicted three L2 learning measures: (1) Spanish vocabulary, (2) a test of Spanish competency, and (3) the course grade in Spanish 1. The latter two outcome variables included measures of vocabulary knowledge, as well as participants' knowledge of Spanish grammar (conjugations of verbs), and Spanish listening and reading comprehension abilities.

These findings suggest two things. First,

there appears to exist a common pool of linguistic processes that subserve both native-language (English) and L2 (Spanish) decoding abilities. Second, these results also implicate native-language and L2 phonological-orthographic abilities of college-age students as important predictors of later, higher order language abilities, such as vocabulary, syntax, and reading comprehension. These findings are consistent with the LCDH predictions that higher order language abilities are founded on lower order phonological-orthographic ability.

Studies with elementary-age children (e.g., Durgunoğlu et al., 1993; Gottardo, 2002; Quiroga, Lemos-Britton, Mostafapour, Abbott, & Berninger, 2002) have provided further corroboration of the LCDH (Sparks, 1995). The results showed a cross-language transfer of phonological ability (Gottardo, 2002; Quiroga et al., 2002) and word reading (Durgunoğlu et al., 1993; Quiroga et al., 2002). Children who were able to read words accurately in their native language (Spanish) were also better at reading words accurately in their L2 (English). Moreover, both Durgunoğlu et al. (1993) and Quiroga et al. (2002) showed that children's native language (Spanish) phonological awareness predicted their individual word-reading ability in English.

As further support for the LCDH, Comeau, Cormier, Grandmaison, and Lacroix (1999) found high correlations between children's native-language (English) and L2 (French) phonological awareness abilities ($r = .89$, $p < .001$). Furthermore, they also showed that native-language and L2 decoding abilities in these children were also highly correlated ($r = .87$, $p < .001$). Hence, the evidence we have reviewed thus far appears to suggest that both native-language and L2 phonological and phonological-orthographic (decoding) abilities are based on linguistic processes that are not specific to any given language.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Our goal in this chapter has been to present behavioral evidence that the ability to form

accurate phonological representations of novel words (or phonological ability) plays an important predictive role in L2 learning. The behavioral data we reviewed first showed that individual differences in this ability predicted native-language vocabulary and reading comprehension. We then presented evidence suggesting that phonological ability is also implicated in L2 vocabulary and reading comprehension abilities. Finally, we considered the relationship between native-language and L2 lower level phonological and phonological-orthographic abilities, and concluded that the linguistic processes that subserve these abilities in a native language are also recruited in an L2. However, whether the processes that subserve phonological and phonological-orthographic abilities are really linguistic in nature deserves consideration in future work.

In summary, there appears to be sufficient evidence to suggest that the ability to perceive and represent novel word forms accurately precedes and partly predicts higher-level language abilities, such as vocabulary and reading comprehension. Hence, individuals who demonstrate more ability in this area, either innately or through educational experiences, are likely to learn an L2 more easily and quickly than those who have less ability.

Although in this chapter we have focused exclusively on behavioral studies, we believe that neural imaging techniques (e.g., functional magnetic resonance imaging [fMRI]; diffusion tensor imaging [DTI]) can further illuminate the nature of individual differences in L2 learning. The behavioral evidence we have reviewed in this chapter and relevant fMRI experiments (e.g., Hasegawa, Carpenter, & Just, 2002; Kim, Relkin, Lee, & Hirsch, 1997) present corroborating evidence that first- and second-language processing rely on some of the same neural structures. We expect that natural variation in the microstructure of these regions will result in a strong correlation in first- and second-language ability. A corollary of this assumption is that this underlying ability is responsible for processing across many linguistic levels and may even predict the acquisition of syntax.

Newer research on the neural bases of

reading and literacy promises to provide important insights into the neural bases of L2 learning. We predict, for example, that white matter density in temporoparietal areas will be shown to correlate with L2 learning, because the underlying phonological abilities necessary for processing an L2 rely on some of the same neural structures used in reading.

Currently, studies in these areas are lacking and need to delineate further the neural bases of L2 learning. We hope the ideas proposed in this chapter will encourage such research. The answers provided by these studies should help to characterize further the nature of L2 acquisition. By integrating studies at the behavioral and neural levels, we can begin to arrive at a more accurate and comprehensive theory of L2 learning and literacy development.

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