Reconsidering Factors Affecting the Acquisition of Novel Second Language Phonemes: A Study of Hungarian ESL Learners

Ferenc Bunta
Arizona State University

1. Introduction

A number of factors have been claimed to influence second language phonological acquisition from motivation to linguistic universals to age of arrival to the target language environment. However, the relative impact of various factors affecting the acquisition of a second language phonological system warrant closer scrutiny. The present paper considers three major factors that have been claimed to affect second language phonological acquisition: accuracy with perception, age of arrival to the target language, and the use of the learners' first language (L1). This paper also attempts to evaluate the relative impact these factors have on the production accuracy of a novel segment.

Flege (1995) suggests that the speech production accuracy of second language (L2) learners is limited by their perceptual accuracy. That is to say, accuracy with perception is as good as or more advanced than accuracy with production of the same sound segment. Flege, MacKay, and Meador (1999) examined the production and perception of English vowels by highly experienced native Italian speakers of English, and they found significant correlation between measures of English vowel perception and production. Flege and his colleagues have found a link between perception and production consistently (cf. Flege, 1993; Flege, Bohn, & Jang, 1997). The Speech Learning Model (SLM), developed by Flege and colleagues, posits that accurate L2 segmental production cannot occur unless there is accurate perception. Furthermore, first and second language phonetic subsystems are not fully separate, and first language phonological acquisition capacities remain intact throughout the life span (cf. Flege, 1995). Hence, according to the SLM, there is no categorical critical period in phonological acquisition that would significantly hinder the acquisition of a second language sound system (an issue that will be revisited in this section).

Other models that focus on speech perception and production are also available for second language phonological acquisition. Kuhl (1991, 2000, 2001) suggests that a "perceptual magnet" exists for humans; also known as the Native Language Magnet (NLM). The basic premise is that prototypes are powerful anchors for given phonemic categories, and they function as perceptual magnets to strengthen their respective categories. Kuhl (2000) notes that humans exploit particular auditory features, and perception becomes altered (i.e., the perceptual space becomes warped) to serve language. The perceptual magnet effect manifests itself by 6 months of age (Kuhl, 1991, 2001). Kuhl, Williams, Lacerda, Stevens, and Lindblom (1992) found that 6-month-olds recognize native prototypes (e.g., Swedish infants recognize /y/ as a prototype, while American infants identify the /i/ prototype) and treat the non-native sound as a non-prototype.

The NLM can also be extended to second language phonological acquisition. Iverson, Kuhl, Akahane-Yamada, Diesch, Tohkura, Kettermann, and Siebert (2003) investigated the perception of English /l/ and /ɹ/ by a group of German English as a second language (ESL) learners, a group of Japanese ESL learners, and a native English group. The authors found that while English and German speakers distinguished the two English liquids on the basis of changes in F3, Japanese learners listened for a different cue, namely, F2. Native speakers of English had the sharpest between-category distinctions and the poorest within-category discrimination. German ESL learners roughly followed the English pattern with less distinct between-category discrimination. On the other hand, Japanese

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ESL learners had significantly poorer between-category discrimination, but they had more acute within-category distinctions than German ESL learners and native English speakers.

Frieda, Walley, Flege, and Sloane (1999) conducted a study to investigate adults' prototypes for the vowels /i/ and /Y/, and they discovered that while adult English learners agreed mostly on the prototype /i/, there was no strong evidence for poorer discrimination around the prototype, something the NLM would have predicted. Overall, discrimination was somewhat better for non-prototypes, but the discrimination around the prototype was not especially poor. Thus, only tentative support was provided for prototype effects. More intriguing observations were made by Frieda, Walley, Flege, and Sloane (2000), who honed in on the /i/ prototypes of native English-speaking adults. They discovered that only 24 out of 35 adults met the criteria for the /i/ prototype. Those participants that had a prototype actually had a more extreme representation (more fronted and higher than a typical /i/) as a prototype, which actually matched the respective speakers' hyperarticulated form. Thus, it seems that a more extreme, hyperarticulated form of /i/ was the prototype for the participants in this study rather than a central categorical exemplar.

A third theoretical model that posits a perceptual basis for speech sound differentiation is the Perceptual Assimilation Model (Best, 1995). The Perceptual Assimilation Model (PAM) predicts that second language segments will be perceptually assimilated to L1 phonemes (cf. Best, McRoberts & Goodell, 2001). There are three ways in which a non-native segment may be perceptually assimilated to the native phonological system: (1) mapped onto a native phoneme varying in range from an excellent to a poor exemplar, (2) uncategorized phone falling between native categories (i.e., roughly equally similar to more than one phoneme), and (3) nonassimilable sound that is very different from any native phoneme. PAM predicts that if an L2 contrast is similar to a native contrast, discrimination will be excellent; differentiation of sound segments will be somewhat worse but still good if the contrast is perceived as the same native category with one good and one poor exemplar, and the distinction will be much worse if two non-native segments are the same in goodness of fit with respect to a native category. As the SLM, PAM allows for later acquisition noting that "even limited exposure [to the target language phonemic contrasts] in adulthood can improve performance to some extent" (Best, McRoberts & Goodell, 2001, p. 776).

The existence of a critical period in second language acquisition has been a much debated issue. While the age at which one starts learning a second language does seem to influence ultimate L2 attainment, the reasons behind this phenomenon are not agreed upon. Lenneberg (1967) states that there is a critical period for learning a first language that ends around puberty due to cerebral lateralization. The loss of brain plasticity results in making the acquisition of a first language extremely difficult after puberty (1967, p. 179). The notion of a critical period for language acquisition has also appeared in second language acquisition, and arguments for and against it appear to reside on a continuum from strong supporters of the critical period hypothesis (see Patkowski, 1990; 1994) to researchers who argue against it (cf. Flege, 1987; Flege & Liu, 2001). Oyama (1982) takes a more conservative approach and notes that while age of arrival is a very strong factor in second language acquisition, there appears to be a sensitive rather than a critical period for second language acquisition. Johnson and Neport (1989) found that Chinese and Korean ESL learners who arrived to the target language environment before 7 years of age possessed native-like grammatical knowledge, which declined steadily from 7 years of age to puberty, and after puberty, L2 learners displayed non-nativelike patterns with large individual variation. Birdsong and Molis (2001) replicated Johnson and Newport's study with Spanish ESL learners and found similar effects, except that the age effect started to asymptote at 27.5 years of age rather than after puberty, and some late learners did achieve native-like proficiency.

Flege and his colleagues acknowledge that age of arrival affects L2 phonological acquisition, but they claim that there is no critical period that would prevent later learners from acquiring a second language sound system. L2 sound category formation becomes more difficult as L1 categories develop, but the capacity to perceive foreign speech sounds and build new phonemic categories stays intact throughout the life span (cf. Flege, 1995; Flege, Bohn, & Jang, 1997; MacKay, Flege, Piske, & Schirru, 2001).

The third variable included in this study is the L2 learners' first language use, a factor that has been investigated by Flege and his colleagues. When comparing high versus low L1 use by L2

learners, Flege, MacKay, and Meador (1999) observed that L1 use did not seem to have a significant impact on the production and perception of English vowels by Italian ESL learners. MacKay, Flege, Piske, and Schirru (2001) found that Italian ESL learners who reported low L1 use tended to produce fewer prevoiced stops and sounded more English-like than high L1 users. However, the differences between low versus high L1 users were only marginally significant.

This study investigates how the production of a non-native segment (/æ/) by Hungarian ESL learners is affected by three factors: accuracy with perceiving the same segment, age of arrival to the target language environment (United States), and L1 use. /æ/ is typically difficult to acquire by Hungarian ESL learners, and it is common for Hungarian learners (especially beginner and intermediate speakers) to substitute [ɛ] for /æ/ (András & Stephanides, 1990, p. 55). Hungarian does have /ɛ/ in its phonemic inventory that is phonetically similar to its American English counterpart, but the American English low front vowel (/æ/) often poses a challenge for Hungarian ESL learners. Hence, /æ/ offers an interesting test case for observing L2 segmental acquisition.

The aim of the present paper is to evaluate the relative importance of accuracy with perceiving /æ/, age of arrival to the US, and use of L1 on the accuracy of producing /æ/. It is hypothesized that accuracy with perception will have the most significant effect, followed by age of arrival, and L1 use will have a marginal effect.

2. Method

Eight Hungarian ESL learners participated in the study. The age of the participants varied from 20 to 54 years with 36.8 years being the mean age. The participants spent between 8 and 12 years in the US uninterrupted, and the age of arrival to the US varied from 11 years to 42 years of age. Data about self-reported L1 use were also collected from the participants (see Table 1).

Table 1. Age of arrival to the US and self-reported percent use of L1.

Participant	Age of Arrival to the US	Percent Use of L1
HF 1	25	60
HF 2	11	40
HF 3	29	50
HF 4	40	90
HM 1	12	10
HM 2	24	80
HM 3	30	50
HM 4	42	80

First, fifty minimal pairs with /ɛ/ and /æ/ were selected. In all of the words, /ɛ/ and /æ/ occurred in stressed position, following an onset consonant or consonant cluster. 90 percent of the items were monosyllabic words and 10 percent were bisyllabic. A perception test involving items from the 50 minimal pairs described above was administered in order to determine how accurately the participants could perceive American English /ɛ/ and /æ/. The participants were given a sheet with 50 minimal pairs that followed the order in which the tokens were read, and the subjects had to check one member of each word pair. The participants could familiarize themselves with the list before the experiment, and they had an opportunity to eliminate unknown words, but the items were not pronounced for them prior to the execution of the test. The participants were presented with a pre-recorded set of words uttered by a female native speaker of American English using a non-distinct ("network standard") variety. The native speaker who read the sample was asked to pronounce each word twice, slowly, clearly, and carefully, leaving a brief pause between the different words.

A list of 144 words was compiled for the production task, 100 of which were actual test items (the 50 minimal pairs containing /ɛ/ and /æ/), and there were 44 foils. In order to avoid the subjects' focusing on the investigated items, the words were purposefully arranged so that minimal pairs would not occur back to back. The recordings obtained from the participants were transcribed by listening to each token at least three times, and transcribing only the vowels. Two judges trained in standard IPA

transcribed the entire sample, and there was a 92% initial inter-rater agreement between the transcriptions. Items that the transcribers did not agree upon were discarded and were not considered for the analyses.

Accuracy with perceiving /æ/ was calculated by simply checking what percent of [æ] sounds were identified correctly by choosing the right word. Consequently, 50% accuracy with perceiving /æ/ would be chance level. Scores for accuracy with producing /æ/ were obtained by taking the percent /æ/ sounds that were pronounced correctly, as determined by phonetic transcription by the judges. The data were entered into regression analyses where the dependent variable was the percent accuracy with producing /æ/, and the independent variables were accuracy with perceiving /æ/, age of arrival to the US, and self-reported percent use of L1.

3. Results

The results indicate that accuracy with perceiving /æ/ has the most prominent effect on accuracy with producing /æ/ ($R^2 = .67$; $F(1, 6) = 12.33$ at $p = .013$). Figure 1 illustrates that as perceptual accuracy involving /æ/ increases, accuracy with producing the same segment also improves, as it was expected.

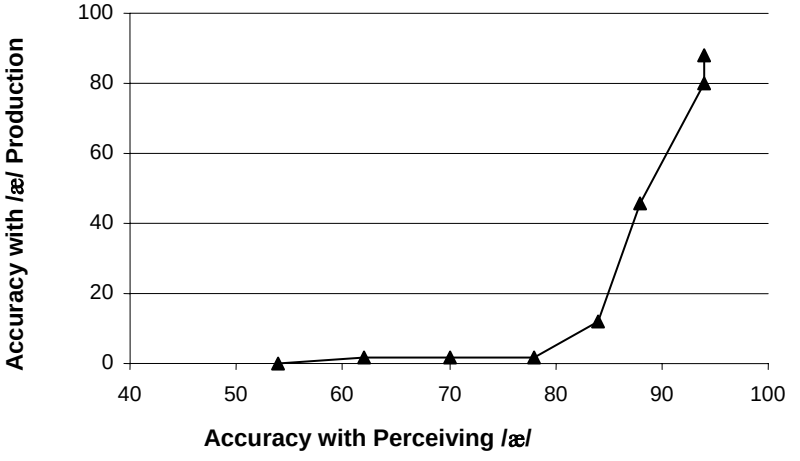

Figure 1. The relationship between accuracy with perceiving and accuracy with producing /æ/.

The second regression analysis reveals that age of arrival is the second most important factor of the variables investigated in this study ($R^2 = .52$; $F(1, 6) = 6.57$ at $p = .043$). However, when an adjustment is made to control for alpha (type I error) inflation, age of arrival is no longer statistically significant. After applying Bonferroni's adjustment for type I (alpha) error ($\alpha = .017$), the only remaining significant factor is accuracy with perceiving /æ/ (see Table 2). Figure 2 illustrates the correlation between age of arrival to the US and accuracy producing a novel second language segment, /æ/.

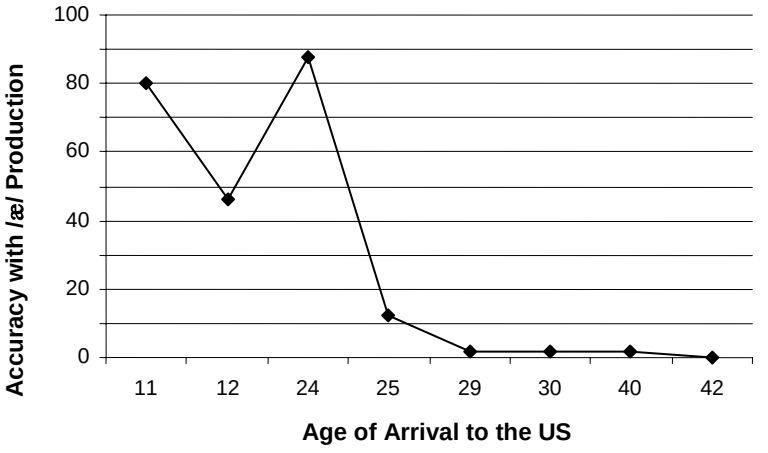

Figure 2. Age of arrival to the US and accuracy with producing /æ/.

The third variable, percent of L1 use does not appear to have a significant effect on how accurately the participants produce /æ/. The regression analysis indicates that the effect of L1 use is negligible ($R^2 = .052$; $F(1, 6) = .326$ not significant at $p = .589$). Figure 3 demonstrates the lack of any possible trend as a result of the participants' L1 use.

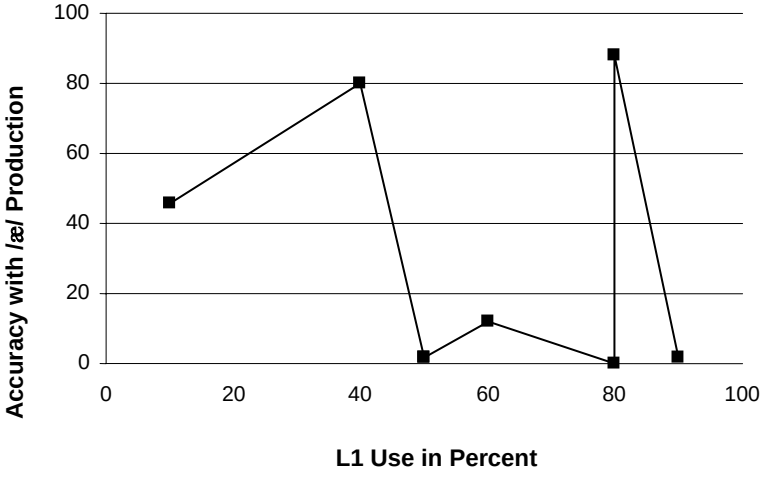

Figure 3. L1 use and accuracy with producing /æ/.

Table 2 summarizes the results of the regression analyses. It has to be noted that the numbers below represent separate regression analyses without having different variances partialed out. As the table indicates, an adjustment was made to the significance level so as to control for type I (alpha) errors, reducing the actual significance level to .017.

Table 2. Factors affecting accuracy with producing /æ/.

Independent Variable	R^2	F (1, 6)	Significance ($\alpha = .017$)
Accuracy with perception	.673	12.33	.013*
Age of arrival to the US	.523	6.57	.043, not significant
Percent use of native language	.052	.326	.589, not significant

* Significant according to the adjusted alpha level.

4. Discussion

The results of the present study offer further support for theoretical models that place a strong emphasis on perceptual bases for developing L2 segmental categories. It appears that successful production of a novel L2 sound segment is strongly affected by perceptual accuracy involving the same sound segment. The results of this study indicate that even age of arrival to the target language environment shows somewhat less of an effect than perceptual accuracy. Considering the Speech Learning Model (Flege, 1995), the Native Language Magnet (Kuhl, 2000; 2001), and the Perceptual Assimilation Model (Best, 1995), all of these theoretical models predict the pattern found by this study. Regardless of the learners' age of arrival to the target language environment, it seems that accuracy with perception has more impact on success with production than does maturation. That is not to say that maturational effects do not exist or cannot hinder phonological acquisition, but even if they do exist, age effects certainly seem not to be deterministic. Current research indicates that previous notions of an absolute critical period for second language acquisition are not supported (cf. Birdsong & Molis, 2001; Flege & Liu, 2001). As Flege (1995) suggests, the ability to establish new phonemic categories remains available throughout one's life. However, the precise nature of the interaction of existing L1 phonemic categories, maturation, and novel L2 segment category formation require further and more in-depth investigation.

This paper is not without its limitations, so the results are to be evaluated with caution. There are a number of factors that may affect second language phonological acquisition that have not been discussed here (such as length of residence, motivation, linguistic universals, etc.). Piske, MacKay, and Flege (2001) provide a useful review of the factors that affect the degree of foreign accent in a second language. Major's (2001) book on foreign accent is also a valuable comprehensive resource for considering factors that have an impact on foreign accent and second language phonological acquisition. Having a more comprehensive account of variables that have an impact on the foreign accent of second language learners is beyond the scope of this paper.

The number of participants is too small to reach any definitive conclusion. More participants and a wider range of ages and skill levels need to be represented for more thorough analyses. Nevertheless, while more data need to be collected and evaluated, certain promising trends do seem to emerge from the present study. Analyzing the relative impact of perception and other factors on L2 phonological acquisition needs further exploration.

One of the major challenges for future L2 phonological acquisition research is to tease out and weigh the various factors that affect the acquisition of second language sound systems. A number of variables in second language acquisition may be intercorrelated, which makes separating the variables, determining their interaction and their relative significance more challenging. Precise and comprehensive designs are required to separate not only the different factors, but also to evaluate their relative significance and their interaction. Nevertheless, understanding L2 phonological acquisition better may have significant ramifications not only for second language phonological acquisition, but also for bilingual language acquisition and second language instruction.

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