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Sound Feature Interference Between Two Second Languages: An Expansion of the Feature Hypothesis to the Multilingual Situation in SLA

RIKA AOKI & FUMIAKI NISHIHARA

Department of Language and Information Sciences, University of Tokyo

Introduction

In this paper, we examine whether interference¹ exists between one second language (L2) and another L2 in a monolingual setting, and suggest that the existing second language acquisition (SLA) theory known as the feature hypothesis (Flege 1995) should be extended to this interference. In particular, we conducted an experiment on English Voice Onset Time (VOT) by Japanese learners. In the original feature hypothesis of Flege, it was suggested that L2 features not used in L1 will be difficult to perceive for the L2 learner. We modify the hypothesis so that it could cover the difficulty in acquiring features which have not appeared in former acquired language(s). Moreover, the result of present study implies that interference can occur non-directionally (i.e. both from a previously learned L2 to an L2 learned later and vice versa), and regardless of learners' proficiency.

It is common that a speaker has multiple L2s. Although there are a considerable number of studies on multiple L2 learning especially in the areas of pragmatics (Williams and Hammarberg 1998, Jordà 2005) and lexis (Dewaele 1998, Rossi 2006), the phonological acquisition of multiple L2s is not well documented. Moreover, most SLA theories on phonological learning refer to the relationship between one's first language (L1) and L2, not mentioning the relationship between multiple L2s. Therefore we need to expand a relevant SLA theory so that we can explain multiple L2 acquisition.

A number of researchers have proposed theories of phonological acquisition by L2 learners. One of the most important theories is the Speech Learning Model (SLM) of Flege (1995), which explains the sound acquisition process of L2 learners who have a certain amount of L2 learning experience. Flege explains that the

¹ Here the term "interference" refers not only to negative transfer but also to positive transfer.

proficiency of L2 pronunciation largely depends on perception ability, and hypothesizes that distinctive features play an important role in perceiving and producing L2 sounds. In other words, L2 features not used in L1 will be difficult to perceive for the L2 learner. This hypothesis is called the feature hypothesis, and has been supported by several previous studies (Munro et al. 1996, McAllister et al. 2002). However, it is still unknown whether it is possible to apply the feature hypothesis to multiple L2 learning.

Our claim will be that the feature hypothesis could also be applied to multiple L2 acquisition, and therefore SLA theories should consider not only L1 and L2 but also multiple L2s as well. We propose an extended version of the feature hypothesis as follows: an L2 feature is easy to acquire if the feature is used in any acquired language. To prove this, we conducted an experiment on English VOT by multiple L2 learners.

In the next section, we will define the terminology on additional languages used in this paper. Then we review the literature on additional language acquisition and existing models of SLA in section 2. In section 3, we explain the method of our experiment on VOT. Section 4 shows the result of the present experiment. Finally, we expand the feature hypothesis and furnish an argument against other probable expansions in section 5.

1 Terminology on Additional Languages

In this section, we review the terminology on additional languages which frequently appears in the studies of SLA and state our own definition.

A considerable number of studies have dealt with three or more languages within one person. Nevertheless, there is no common view on what additionally acquired languages should be called, and different researchers use different terms for them. Before turning to an examination of terminology in previous studies, we shall briefly outline here our definition of additional languages.

We classify an individual's languages in terms of the critical period. Namely, we define L1 as language(s) acquired during the critical period, and L2 as language(s) acquired after the critical period. It should be noted that one person may have multiple L1s or multiple L2s.

Let us now look at the terminology used in previous studies. In research on additional language acquisition, it is common practice to use terms based on the concept of the linear order of language learning. In this "linear model" (Hammarberg 2010), the language acquired first is called L1 (first language), the second acquired is L2 (second language), and the third one is L3 (third language): in this way, learners' languages are numbered in an acquisition order.

In the linear model, L3 can refer to three completely different situations: (i) L3

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as a native language;² (ii) L3 as the first non-native language;³ (iii) L3 as the second non-native language.⁴ This practice has become common because it is apparently quite simple and clear. However, there are various problems and contradictions, as referred to in Hammarberg (2010). According to him, the linear model fails to cover the following five situations: (i) languages acquired simultaneously; (ii) language(s) acquired with only scanty knowledge; (iii) language(s) acquired with limited types of knowledge;⁵ (iv) language(s) acquired intermittently; (v) language(s) acquired almost unintentionally due to the closeness of the languages.⁶

There is another model which approaches acquired languages differently from the linear model. The basis of this model is the critical period hypothesis, which we hereby name the “CP model”. That is, an acquired language is named based on whether it is learned before or after puberty, and those acquired before puberty are L1s, while those after puberty are L2s. Following this model, some of the problems mentioned above could be solved. For example, in the linear model, it is impossible to determine the acquisition order of languages acquired simultaneously. On the other hand, in the CP model the order does not matter in determining L1/L2 because the definition of L1/L2 does not include the acquisition order, and the model allows one to possess multiple L1/L2s (Cawhalho and da Silva 2006, Davidiak 2010).

Hammarberg (2010) proposes another terminology for acquired languages, especially those which are learned after one has acquired the first L2. He focuses on these languages because he thinks they have a special status due to the knowledge, experiences, and strategies which a learner can gain from learning the first L2. Therefore, in his definition, he distinguishes L1 (acquired before puberty), L2 (acquired after puberty), and L3⁷ which is defined as follows:

[T]he term *third language (L3)* refers to a non-native language which is currently being used or acquired in a situation where the person already has knowledge of one or more L2s

² Though this situation seems to be rare, Davidiak (2010) reports twins with three “native languages.” The twins have a German-native-speaker father and a Spanish-native-speaker mother, and were brought up in an English-speaking society, namely New York. Thus the twins can handle three languages as native languages.

³ For example, in a study of English acquisition in the Catalan Countries in Spain, Jordà (2005) described the language condition of Catalan-Spanish bilingual learners as L1 for Catalan, L2 for Spanish, and L3 for English.

⁴ This can be seen in Williams and Hammarberg (1998), where the informants were native speakers of English who learned German as L2 and Swedish as L3.

⁵ Hammarberg (2010) states that it is difficult to determine which type of linguistic knowledge, that is, reading, writing, listening or speaking, is required for a learner to be judged as having acquired a language.

⁶ Hammarberg (2010) provides Scandinavian languages as an example: people with Swedish knowledge can easily comprehend Norwegian and Danish with minimal disruption.

⁷ Hammarberg (2010) proposes alternative unabridged forms of L1, L2, and L3 as primary, secondary, and tertiary language, respectively, instead of traditional first, second, and third language. This is because the traditional terms based on ordinal numerals are reminiscent of the linear model.

in addition to one or more L1s. (Hammarberg 2010:97)

In this paper, we follow the CP model, the one based on the critical period hypothesis. This is because of the fact that phonological acquisition tends to be the “first ability to be lost” (Piske et al. 2001) after the critical period, compared to the acquisition of other linguistic levels such as syntax or semantics, which can be understood from the fact that some researchers claim an earlier critical period closure for phonology (Seliger 1978, Long 1990). In addition, although some of the previous studies on the SLM follow the linear model and others employ the CP model, the age of learning has been considered as one of the most influential factors on L2 sound acquisition (Flege 1998, Piske et al. 2001). This suggests the validity of the CP model.

2 Previous Studies

In this section, we examine several previous studies. First we review the literature of additional language acquisition both in non-phonological areas (2.1) and in phonology itself (2.2). In 2.3, we discuss problems of the previous studies. Finally, we provide an introduction to Flege (1995)’s sound acquisition model, the SLM, and its component, the feature hypothesis, in 2.4.

2.1 Non-phonological Additional Language Acquisition

Although a considerable number of studies on additional languages have dealt with “L3,”⁸ they have been superficial so far. These studies have described the multiple L2 situation, but few studies have tried to establish a new theoretical model of language acquisition. In consequence of this, such a new model is inevitable.

Most of these previous studies discuss pragmatic (Williams and Hammarberg 1998, Jordà 2005) and lexical (Dewaele 1998, Rossi 2006) acquisition of “L3,” and phonological studies are relatively rare. For example, Williams and Hammarberg (1998) describe the pragmatic strategies of English native speakers who learned German and Swedish in that order. They found that the learners adopted a strategy in speaking Swedish. This strategy was observed in German but not in English. Thus, it can be concluded that L3 acquisition was influenced not by L1 but by L2. As for lexical studies, Rossi (2006) observed L3 (Spanish) lexical learning process of two groups of learners: those whose L1 was English and L2 was French; and those whose L1 was French and L2 was English. We may note, in passing, that Rossi’s study was conducted in Canada, a bilingual society.⁹ The result shows that the influence of French on Spanish lexis was great regardless of the groups, which

⁸ It should be noted that there exists no consensus on the definition of L3 as discussed in section 1.

⁹ In contrast, Williams and Hammarberg (1998) conducted their research in largely monolingual society.

indicates that what played an important role in L3 lexical acquisition was language typological distance rather than acquisition order.

2.2 Phonological Additional Language Acquisition

A small number of phonological studies such as Tremblay (2007), Wrembel (2009), Llama et al. (2010), and Wunder (2010) have investigated patterns and influential factors of sound acquisition of multiple L2s. Their results indicate that one L2 (acquired earlier) has an impact on the acquisition of another L2 (acquired later). For example, the study of Tremblay (2007), which observed the influence of L1 English and L2 French on L3 German production, found some effects of L2, although those of L1 were greater in all experimental groups categorized in terms of L2 proficiency and L2 exposure. In the study of Wrembel (2009), the fundamental frequency distribution of L3 English by native Polish speakers whose L2 is German was investigated. She claims that L3 was affected by L2 rather than L1. Llama et al. (2010) investigated the phonetic influence of typological distance and L2 “privileged status.” Their participants were two groups of L3 Spanish learners: those who spoke English as L1 and French as L2; and those who did the opposite. The result suggests that L2 privileged status was a stronger predictor. Wunder (2010) studied Spanish VOT by L3 learners with L1 German and L2 English. She concluded that L3 VOT was affected by both L1 and L2, while she stressed the importance of L1.

2.3 Problems of Previous Studies

As mentioned in 2.1 and 2.2, there are a number of previous studies on additional languages. However, these studies lack completeness in terms of the following three factors: (i) sociolinguistic situation; (ii) the direction of interference; (iii) proficiency in the source language.

Here “sociolinguistic situation” indicates language use in a society, especially bilingualism or monolingualism.¹⁰ Most previous studies on interference between multiple L2s have been conducted in multilingual societies such as the Catalan Countries in Spain (Jordà 2005), and the Francophone states in Canada (Dewaele 1998, Rossi 2006). Studies conducted in monolingual societies are relatively rare. As for the direction of interference, previous studies have put focus on the transfer from an earlier acquired L2 to a later acquired L2. We must not forget, however,

¹⁰Definitions vary as to bilingualism. It is useful to make a distinction between individual bilingualism and social bilingualism. Individual bilingualism is about personal language usage. On the other hand, social bilingualism is about language usage in a certain society. Social bilingualism is compatible with individual monolingualism, and vice versa. A French monolingual person in Quebec, a French-English bilingual region, is a good example. We will use the term “bilingual/monolingual” in the social sense.

the possibility that a later acquired L2 has an effect on the acquisition of an earlier acquired L2. Most previous studies employ the linear model to define L2, and it follows that they tend to think unidirectionally. The third problem concerns the proficiency in the source language.¹¹ In previous studies, the proficiency in the source language tends to be quite advanced. For example, Llama et al. (2010) report that their participants had a high command of their L2. However, little attention has been paid to source language with lower proficiency.

Thus, there are various problems in previous studies on additional language. What is more, these studies have reported only their observations on additional language acquisition, without referring to existing models in SLA. Therefore, it is necessary to expand the existing model so that we can explain the observations of additional language studies.

However, looking at the existing models, additional languages do not seem to be taken in consideration. These models explain interference from L1 to L2, but not between multiple L2s. Before discussing this problem, let us review one of the existing models, namely the Sound Learning Model (SLM).

2.4 SLM and the Feature Hypothesis

Among a number of SLA models, the SLM of Flege (1995) is one of the most influential models in sound acquisition. Flege places special emphasis on the acoustic nature of L2 sounds rather than their phonological categories. He also stresses the close connection between production and perception:

The production of a sound eventually corresponds to the properties represented in its phonetic category representation. (Flege 1995:239)

The SLM is composed of several hypotheses. Among these hypotheses, we focus on the feature hypothesis, which deals with the sound system difference between L1 and L2. The feature hypothesis predicts that learners may find difficulties when they perceive/produce sounds with features not used in their L1. As an example of the feature hypothesis, Munro et al. (1996) investigated the production of English /ə/ by Italian native speakers, and report that the participants found difficulty in producing the sound. This is because their L1 does not have the retroflex feature.

It is noteworthy that “feature” in the feature hypothesis is not identical to “feature” in general phonology. Flege’s “feature” includes not only phonological features but also phonetic differences. English aspiration is a good example. In English, aspiration is not distinctive, and therefore is not a phonological feature. On the other hand, the feature hypothesis considers English aspiration as a feature because there is a phonetic difference between aspirated and unaspirated consonants.

¹¹In this context, “source language” refers to the causer of interference, while “target language” indicates the causee.

As mentioned above, the feature hypothesis explains interference between L1 and L2. However, we still need to investigate whether it is possible to apply the feature hypothesis to multiple L2 learning. In the present paper, we show the validity of the expansion of the feature hypothesis to multiple L2 acquisition. Thus, the extended version of the feature hypothesis would be the following: an L2 feature is easy to acquire if the feature is used in any acquired language.

3 Method

To examine the validity of the expansion of the feature hypothesis, we conducted an experiment on English VOT by Japanese learners. In this section, we briefly review established facts about VOT in relevant languages (i.e. Japanese, English, Chinese) and show the details of the experiment.

3.1 VOT

In this study, we tested the validity of the extended feature hypothesis in terms of the VOT value of English stops produced by Japanese learners. An important point we wish to stress is that we included Chinese experience as a factor in the present experiment. To begin with, we briefly explain the functions of VOT in the three languages: Japanese, English, and Chinese.

VOT varies among different languages. Aspirated consonants do not appear in Japanese. Although there is no aspirated consonant as an independent phoneme in English, English voiceless stops and affricates (/p/, /t/, /k/, /tʃ/) in a stressed syllable (without being preceded by /s/) are pronounced as aspirated consonants. Namely, aspiration is not phonologically distinctive in English, but aspiration plays an important role in phonetics. On the other hand, in Standard Chinese, aspiration has a phonological distinctive function: there are three unaspirated stops (/p/, /t/, /k/) and three aspirated counterparts (/p^h/, /t^h/, /k^h/). In addition, it has three pairs of affricates (/ts/-/ts^h/, /tʃ/-/tʃ^h/, /tʂ/-/tʂ^h/). VOT can be also affected by places of articulation (Cho and Ladefoged 1999), vowel context (Morris et al. 2008), and tones (Liu et al. 2008), although not all previous studies support this.

Chinese stops show the longest VOT, followed by English and Japanese, respectively. Comparing Chinese and English, Chinese has much longer VOT (Chen et al. 2007). According to Homma (1985), VOT of Japanese is much shorter than that of English.

In contrasting aspirated and unaspirated consonants both phonetically and phonologically, the difference in VOT value rather than absolute VOT value is the key to distinguish the two sounds. In fact, the VOT of aspirated consonants is longer for female or older speakers rather than male or younger speakers (Yao 2009), but to distinguish aspirated consonants from unaspirated ones is not problematic because there are considerable differences between the two in terms of VOT value

regardless of their absolute value.

Thus, Japanese learners are not good at producing sufficient VOT as long as native speakers of English and Chinese. In fact, Homma (1985) and Riney and Takagi (1999) reported that VOTs of stops produced by Japanese learners of English are shorter than English native speakers. Just as in English production, Japanese learners find difficulties in Chinese VOT (Wang and Shangguan 2004). These difficulties can be explained by the feature hypothesis. That is, their inaccuracy is due to the fact that Japanese, their L1, does not have an aspiration feature.¹²

The different status of VOT in English and Chinese also affects L2 teaching. In fact, aspiration is taught explicitly in Chinese classrooms in Japan, while not in English ones. Thus, Japanese learners of English, provided that they have not studied Chinese, do not pay attention to aspiration.

3.2 Subjects

Three groups of speakers participated in the recording. No subjects reported any known speech or hearing disorders.

- Experimental group ($n = 6$): Japanese native speakers who had learned Chinese for 1-4 years.
- Non-native control group ($n = 6$): Japanese native speakers who had never learned Chinese.
- Native control group ($n = 2$): English native speakers from England who had been teaching English at a university in Japan for more than two years.

Both Japanese groups received the “standard” language training of English in Japan (six years of instruction in junior and senior high school, and some language classes at university). They were either undergraduate or graduate students in Japan, and had not lived in English-speaking or Chinese-speaking regions for longer than one year.

3.3 Equipment

The recording was carried out in the soundproof booth of the University of Tokyo. A digital audio recorder (Cool Edit Pro Version 1.2) and a dynamic microphone (SONY ECM-MS957) were used for the recording. The audio signals from each

¹²VOT exists in Japanese consonants as indicated in Homma (1985). However, Japanese VOT can be considered articulatory rather than functional. In fact, Japanese VOT is almost as short as unaspirated consonants in English and Chinese. In addition, Japanese does not contrast between longer VOT (aspirated) and shorter VOT (unaspirated) either phonetically as in English or phonologically as in Chinese. Therefore, this paper considers that Japanese does not have a VOT feature.

speaker were digitized at 44.10 kHz with 16 bits of amplitude resolution. The digitally recorded audio signals were edited with the sound analysis program Praat Version 5.2.11 (Boersma and Weenink 2011). Aspiration boundaries were carefully determined by listening to selected parts of the audio signal and by visual inspection of the speech waveform and spectrogram.

3.4 Tasks and Procedure

Fifty-four meaningful English target words with all possible combinations in terms of place of articulation (labial, alveolar, velar), height of succeeding vowel (high, mid, low), and aspiration (aspirated, unaspirated) were selected. We put these target words and filler words into carrier sentences as follows: *don't say "X", say "Y"* (see Appendix).

Target or filler words were positioned in X or Y or both, and every word was paired up with a semantically related word in the same carry sentence; for example, *spice/pepper* (both target), *pass/fail* (former: target; latter: filler), or *fire/water* (both filler). Thus we made 54 English sentences, sorted these task sentences at random, and printed them. Every subject was asked to look through the sentences once, in order to check if there were any unknown words. After that, they were required to read aloud the task sentences at natural speed. They were allowed to repeat if they made an error.

4 Results

Table 1 and Figure 1 summarizes the result of the experiment. We conducted a two-way ANOVA with the main effect of group (experimental group, non-native control group, native control group), the main effect of aspiration (aspirated/unaspirated), and their interaction. This test shows group effect ($F(2, 728) = 35.81, p < .001, \eta^2 = .098$), aspiration effect ($F(1, 728) = 383.02, p < .001, \eta^2 = .526$), and interaction of the two main effects ($F(2, 728) = 18.49, p < .001, \eta^2 = .051$) were highly significant.

Table 1: Mean VOT Values Produced by Each Subject Group

	Aspirated	Unaspirated
Experimental Group	88.2 msec	31.5 msec
Non-native Control Group	53.4 msec	24.7 msec
Native Control Group	78.3 msec	21.9 msec

In Figure 1, an important point is the VOT differences between aspirated and unaspirated stops in each subject group. The non-native control group did not show substantial VOT difference, while the experimental group and the native group did.

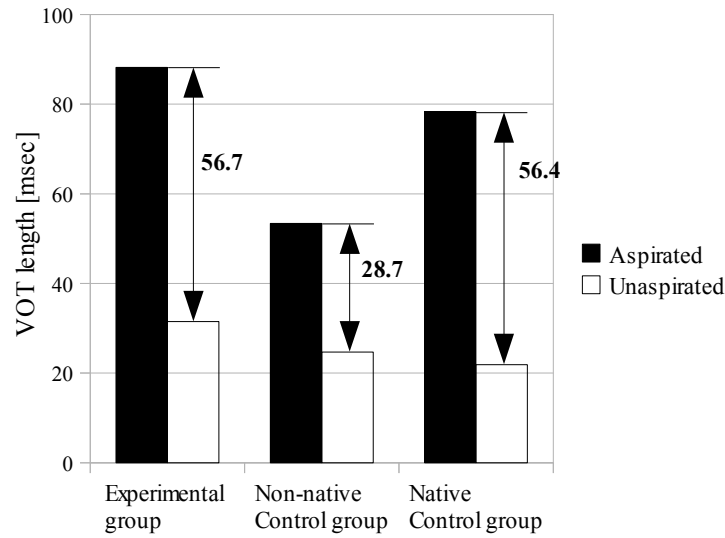


Figure 1: The VOT Difference in Each Subject Group

Here, we should note that the VOT difference of the experimental group was similar to that of native control group. Though the mean VOT of the experimental group was longer than that of the native control group, this point is not important when we discuss the acquisition of the aspiration feature. This is because, as mentioned earlier, the difference in VOT value is more critical to aspiration contrast than absolute VOT value.

The results indicate that the experience of Chinese contributed to the production of English VOT. In other words, the acquired category in Chinese (i.e. aspiration) helped the distinction in English, even though the participants had learned English before Chinese and had higher proficiency in English (target) than Chinese (source).

5 Discussion

This section firstly proposes our expansion of the feature hypothesis based on the findings in the previous studies and our experiment (5.1). In 5.2, other possible expansions of the hypothesis will be discussed, and we argue for the validity of our expansion.

5.1 Main Findings and the Expansion of the Feature Hypothesis

As mentioned in section 4, the VOT difference between aspirated and unaspirated stops was sufficient both in the experimental group and the native control group, but not in the non-native control group. This can be interpreted that the experimental

group is native-like in terms of aspiration, while the non-native control group is not. It suggests that one L2 (i.e. Chinese) affected the other L2 (i.e. English) in a monolingual setting, although the proficiency of the source language was not necessarily high in any participants in the experimental group.

This result does not agree with the original feature hypothesis, which states that learners will have difficulty in perceiving and producing target language features not used in L1. In this experiment, L1 and the target language of the experimental group were same as those of the non-native control group. It follows that the VOT acquiring pattern of the two groups should be equal according to the original formation of the feature hypothesis.

Therefore, if we try to explain our result in terms of the feature hypothesis, it is required to extend it, as mentioned in 2.4: an L2 feature is easy to acquire if the feature is used in any acquired language. This extended version of the feature hypothesis can account not only for our results but also for those of previous studies which report interference between multiple L2s.

5.2 Background Factors in Interference Between Multiple L2s

Comparing with the setting of our experiment with those of previous studies (Tremblay 2007, Wrembel 2009, Llama et al. 2010, Wunder 2010), differences in three main factors can be found as in Table 2.

Table 2: Major differences in the background factors

	Previous Studies	Our Study
Sociolinguistic Situation	(Relatively) Bilingual	(Relatively) Monolingual
Direction of interference	Earlier Acquired L2 → Later Acquired L2	Later Acquired L2 → Earlier Acquired L2
Proficiency of Source Language	High Proficiency	Low Proficiency

These factors have been touched on in 2.3. Our extended version of the feature hypothesis is not subject to these three factors. Now we discuss the relationship between these factors and the expansion of the feature hypothesis. There are several objections which can be raised against this extension, and indeed it is possible to extend the feature hypothesis in a more limited way. Putting together the results of previous studies and the present study, however, such limited extensions are not satisfactory.

First of all, we might extend the feature hypothesis only to bilingual settings if we merely consult previous studies in bilingual societies. Considering the present study was conducted in a monolingual setting, it can be concluded that the feature hypothesis is applicable regardless of bilingualism.

In the same way, it may be possible to extend the feature hypothesis to explain interference from an earlier acquired L2 to a later acquired L2. Although most previous studies have observed the influence from an earlier acquired L2 to a later acquired one, our finding was in the opposite direction. Therefore, it is possible to suggest that interference could occur in both directions: either from a previously acquired language to a newly acquired one, or vice versa.

Finally, it has often been the case that the proficiency in the source language was relatively higher than that of the target language. In the present study, however, the source language (i.e. Chinese) proficiency of the participants was not as high as the target language (i.e. English) proficiency. Therefore, it can be suggested that one L2 can affect the other L2 acquisition regardless of one's proficiency in the source language, which means that the production of learners with any proficiency level could be explained by the feature hypothesis.

Thus, our extended version of the feature hypothesis can cover not only traditional interference from L1 to L2 but also multiple L2 interference regardless of background factors which other expansions fail to deal with. Moreover, it is noteworthy that we observed interferences which had not been discussed in previous studies. Our experiment was conducted in a monolingual society, and the interference direction was from a later acquired language with low proficiency to an earlier acquired one.

We therefore extend the feature hypothesis as follows: an L2 feature is easy to acquire if the feature is used in any acquired language.

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Appendix: Examples of experimental sentences

1. Don't say "pan," say "can."
2. Don't say "tool," say "cable."
3. Don't say "keep," say "tie."
4. Don't say "store," say "shop."
5. Don't say "score," say "team."
6. Don't say "wood," say "steel."
7. Don't say "dead," say "living."
8. Don't say "toy," say "school."
9. Don't say "folk," say "spoon."

University of Tokyo
Department of Language and Information Sciences
3-8-1, Komaba, Meguroku, Tokyo 153-8902 Japan

galangalanga@gmail.com, nisihara@phiz.c.u-tokyo.ac.jp