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ABSTRACT

This study looks for support for the suggestion in the Speech Learning Model that the phonetic category established in childhood for a first language (L1) sound may evolve gradually if it is linked perceptually to a second language (L2) sound. Assessed here is voice onset time (VOT) in two groups of five bilingual (English and Japanese) speakers, aged 35-60, one group whose L1 is English and the other whose is Japanese. All reported no significant L2 exposure before age 15, and they had been working in the L2 regularly for 15 to 35 years. Both groups read the same list of English and Japanese words containing word initial /p/, /t/, or /k/. In all 880 tokens (10 speakers multiplied by 2 languages multiplied by 44 tokens per language) were examined. Results found that, for both groups, the L2 VOT mean values were positioned between the normal L1 Japanese and L1 English VOT values. No support was found for the suggestion that speakers' L1 VOT values evolve over time. The L1 values appear to have stayed the same. (Contains 2 tables and 21 references.) (KFT)

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Does Bilingualism Affect the First Language?

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Does Bilingualism Affect the First Language?

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In this report on work in progress we look for support for the suggestion in the Speech Learning Model that "the phonetic category established in childhood for an L1 sound may evolve gradually if it is linked perceptually to an L2 sound" (Flege, 1995, p. 264). Assessed here is voice onset time (VOT) in 2 groups of 5 bilingual (English and Japanese) speakers, one group whose L1 is English and the other Japanese. All 10 speakers were from age 35 to 60. All reported no significant L2 exposure before age 15 and that they had been working in the L2 regularly for 15 to 35 years. Both groups read the same 2 lists of English and Japanese words containing word initial /p/, /t/, or /k/. In all 880 tokens (10 speakers x 2 languages x 44 tokens per language) were examined. We found that for both groups the L2 VOT mean values were positioned between the normal L1 Japanese and L1 English VOT values. We also found no support for the suggestion above that speakers' L1 VOT values evolve over time. The L1 values appeared to have stayed the same.

In what is regarded as a classic voice onset time (VOT) study, Lisker and Abramson (1964) described aspiration and voicing in stops in terms of VOT, or "lag," defined as the time between the release of a stop closure and the onset of vocal cord vibration. Based on their study of VOT in word-initial, singleton, voiceless stops in 11 languages, Lisker and Abramson proposed that across languages there were three general categories of stops that could be defined by their VOT values. These were (1) voiceless unaspirated stops (0 to 25 msec), (2) voiceless aspirated stops (60 to 100 msec), and (3) voiced stops, in which the onset of vibration precedes the release of the closure, resulting in a negative VOT value (e.g., -25 msec).

In the part of a larger project that we report here we address only the voiceless stops. The languages we will consider are Dutch, Japanese, and English, which all have two categories of stops. In Table 1 one sees that the voiceless stops in English (/p/, /t/, and /k/) involve aspiration and a relatively long lag, whereas the corresponding voiceless stops in Dutch involve little or no aspiration and a relatively short lag (Lisker & Abramson, 1964). The corresponding set of voiceless stops in Japanese, however, have been found to be more intermediate in value, ranging from 30 to 66 msec (Shimizu, 1996), and it is not clear whether they should be called aspirated or not (Vance, 1987).

Thus, the Japanese voiceless stops do not fit neatly into either of the two categories of voiceless stops, aspirated and unaspirated, proposed by Lisker and Abramson; Japanese VOT values fall between the two categories. At the bottom of Table 1 are the mean values of the three voiceless stops (/p/, /t/, and /k/) combined. Short lag Dutch is 16.7 msec and long lag English is 69.3 msec. The mean value for Japanese, 45.7 msec, however, is located about midway between the two.

TABLE 1

Mean VOT Values for /p/, /t/, and /k/ in Dutch, Japanese, and English

	Dutch (Lisker & Abramson, 1964) 1 speaker VOT, range	Japanese (Shimizu, 1996) 6 speakers VOT (sd) range	English (Lisker & Abramson, 1964) 4 speakers VOT, range
/p/	10, 0-30	41 (17.1) 15-65	58, 20-120
/t/	15, 5-35	30 (12.7) 15-50	70, 30-105
/k/	25, 10-35	66 (12.1) 50-100	80, 50-135
Mean	16.7	45.7	69.3

Note: Lisker and Abramson (1964) did not report standard deviation (sd).

An earlier and more limited study of Japanese VOT was Homma (1980). Homma's study involved only 3 speakers and only 1 word with a /ta/ onset, *tada* (/tada/, "free"), which is accented on the first mora (or syllable). Homma reported a mean VOT of 25 msec for /t/ and interpreted Japanese VOT to fall between the typical VOT means for voiceless unaspirated /t/ and voiceless aspirated /t/ in other languages. This was counterevidence to Lisker and Abramson's (1971, p. 770) claim that "there is rough agreement across languages in the placement of categorical boundaries along the dimension of voice onset timing, yielding 3 phonetic types: voiced, voiceless unaspirated, and voiceless aspirated stops." (See also Keating, 1984.)

Shimizu's study involved 6 speakers producing /pi/, /pa/, /po/, /ta/, /te/, /to/, /ka/, /ki/, /ke/, /ko/, and /ku/. As a function of the following vowels, his findings for /p/ were 37, 48, and 50 msec before /a/, /i/, and /o/, respectively. (Data was not obtained for /u/ and /i/.) For /t/ they were 29, 29, and 31 msec before /a/, /e/, and /o/, respectively. (The onsets /ti/ and /tu/ involve affrication and were not included.) For /k/ they were 53, 87, 73, 55, and 63 msec before /a/, /i/, /u/, /e/, and /o/, respectively. For the /ta/ onset the findings of Shimizu (29 msec) and Homma (25 msec) were quite close, and this could be used to support Homma's claim that Japanese VOT is different, although Shimizu does not refer to Homma's work.

Vance (1987), based in part on considerations of stressed and accented syllables, questioned Homma's claim. Vance concluded "there is no solid evidence that Japanese /p, t, k/ fall between the putatively universal voiceless unaspirated and voiceless aspirated types in terms of VOT" (p. 19), and tentatively concluded "that Japanese /p, t, k/ are voiceless unaspirated, but VOT in Japanese certainly deserves further study" (p.19). Shimizu's work was published subsequently to Vance's comment, however, and Shimizu's findings support Homma's claim that Japanese VOT values are intermediate. (The results of our study reported below also lend some support to Homma's claim.)

An unacknowledged variable in some VOT studies, however, is the state of monolingualism vs. bilingualism in the speakers' measured. Shimizu's native Japanese (NJ) speakers (age 26–35) were all postgraduate students at Edinburgh and "were considered to have a good command of English" (p. 22). For a review of "observed significant L2 effects on L1 production," see Flege and Eefting (1987a, pp.197–99).

Flege and Eefting studied Dutch speakers of English. One similarity between our study and that of Flege and Eefting (1987a) is that both studies involved an L1 that had voiceless stops with VOT values that were shorter than those of the target language (English). One difference, however, is that whereas Flege and Eefting (1987) involved a short lag L1 (Dutch), our study involves an L1 (Japanese) with an unusual type of intermediate lag that to our knowledge has been investigated only once before (Riney & Takagi, 1999) in a cross linguistic study. We were interested in learning whether NJ speakers could establish new long lag VOT values in English separate from the intermediate lag values of their L1. We were also interested in learning whether the native English (NE) speakers could establish new intermediate lag VOT values separate from the long lag values of their L1.

With its intermediate VOT values, Japanese provided an interesting test case for investigating what phonetic distance (measured as VOT in msec) is required before phonetic modification occurs in the interlanguage. A number of studies have found that groups of adult EFL speakers whose L1 contains short lag stops (e.g., French) will realize as a group English stops with VOT values that are located someplace between the L1 short lag VOT values and the target language English long lag values. Conversely, groups of long lag NE speakers have been found to produce stops in target languages that contain short lag stops with mean VOT values that are positioned between the English long lag norm and the target language short lag norm. (See Flege & Eefting, 1987a, pp. 186–87; Flege & Eefting, 1987b, p. 68; Flege & Hillenbrand, 1984.) Major (1987) and Flege and Eefting (1987a) found that some Brazilian and Dutch (respectively) EFL speakers adjusted their VOT when speaking English to a value that was intermediate between the short lag VOT of their L1 and the long lag VOT of the target language, English.

One question of interest for the current study is whether NJ bilingual speakers, with L1s with intermediate lags and relatively little VOT difference between the L1 and the target language, will produce Japanese and English /p/, /t/, and /k/ diaphones with the same VOT values or with different values. We were also interested in examining the Japanese and English productions of the NE bilingual speakers. We considered four possibilities:

1. The bilingual speakers use their L1 VOT values for both their L1 and their L2. (This means that the NJ speakers, for example, use normal Japanese VOT values for both Japanese and English stops and may be viewed as complete L1-L2 transfer.)

2. The bilingual speakers use the normal L1 English and L1 Japanese VOT values in both languages. (This would mean that the bilinguals spoke both languages like native speakers of those languages, at least with respect to VOT.)

3. The bilingual speakers use some midpoint VOT value (neither L1 nor L2 but between L1 and L2) for *both* their L1 and their L2. This would constitute support for Flege's suggestion in the Speech Learning Model that "the phonetic category established in childhood for an L1 sound may evolve gradually if it is linked perceptually to an L2 sound (Flege, 1995, p. 264).

4. The bilingual speakers maintain their L1 values for their L1, but for the L2 use VOT values positioned at some point between the L1 and the L2 values. (This matches our informal and limited observations before conducting this study, and formed the basis for hypotheses to be presented below.)

If possibility (1) occurred it would be an indication that the VOT difference (or phonetic distance) between the L1 and the target language might be too little to be perceived and adjusted to. This could be attributed to the unusual intermediate values of Japanese and the relatively shorter VOT difference between the Japanese and English values. Speakers, on the other hand, may adjust their L2 VOT values in one of several different ways, suggested by possibilities (2), (3), and (4). Production of an L2 VOT value that is different from the L1 VOT value may be an indication that the VOT difference (phonetic distance) between the two languages was sufficient enough to bring about the formation of new phonetic categories (Flege, 1995). The VOT values in the L2 are either the L2 norm as in possibility (2) or are some intermediate value as in possibilities (3) and (4).

This investigation contributes to research in how learning and acquisition are affected by degrees of similarity and difference between the items a learner possesses and those items the learner intends to acquire. In a review of recent research that is cross linguistic and devoted to the phonological domain, Major and Kim (1996) note that many researchers "have investigated the relationship between phonological similarity / dissimilarity (variously called new or different phenomena) and difficulty or order of acquisition" (pp. 467–68). According to Oller and Ziahosseiny (1970), "wherever patterns are minimally distinct in form or meaning in one or more systems, confusion may result" (p. 186). According to Wode (1983, p.180; cited in Major & Kim, 1996), L1-L2 transfer requires "crucial similarity measures" between the L1 and L2 items. In a similar vein, Flege (1987) used "equivalence classification" to describe that situation where the speaker perceives L2 sounds to be equivalent to those in the L1, and these equivalent sounds are therefore more difficult than new, different, or dissimilar sounds. Major and Kim (1996) have proposed The Similarity Differential Rate Hypothesis (SDRH): "An L2 phenomenon that is dissimilar to an L1 phenomenon is acquired faster than an L2 phenomenon that is similar to this same L1 phenomenon" (p. 474). The SDRH might predict that NE speakers, for example, would acquire short lag Spanish stops more easily than intermediate lag Japanese stops because the VOT values of the former are more distant and different from those of the English stops. Thus, the present study contributes to an established and growing literature that investigates the role of phonological similarity in language learning.

Our review of related literature combined with our own informal observations caused us to favor possibility (4) above and motivated the testing of the following four related hypotheses:

1. As a group the NE bilinguals will produce English stops with VOT values that are normal English VOT values.

2. As a group the NJ bilinguals will produce Japanese stops with VOT values that are normal Japanese VOT values.

3. As a group the NE bilinguals will produce Japanese stops with VOT values that are positioned between normal NE values and normal NJ values.

4. As a group the NJ bilinguals will produce English stops with VOT values that are positioned between normal NJ values and normal NE values.

In the hypotheses above "normal" VOT values are assumed to be normal for monolinguals. For English we use those values reported by Lisker and Abramson (1964). For Japanese, we use Shimizu (1996), whose speakers were to some extent bilingual. We had to use Shimizu for Japanese VOT because we knew of no thorough study of Japanese monolingual VOT values. (We are currently collaborating with a third researcher who is investigating VOT in Japanese monolinguals, but these results are not yet prepared and will be treated in a different paper.)

Method

Speakers

This study involved 10 adult bilingual (Japanese and English) speakers between ages 35 and 60; 5 were native English (NE) and 5 were native Japanese (NJ). Each group included 3 males and 2 females. All speakers reported on questionnaires completed prior to the beginning of this study that they had had no significant L2 exposure before age 15, and that they had been fluent and working in their L2 regularly for 15 to 35 years prior to this study.

All speakers were volunteers from the campus of International Christian University (ICU) in Tokyo and were known to the first author. Speakers were chosen from ICU principally because it was relatively easy for the first author, also based at ICU, to locate them and arrange for them to be recorded on campus. Without informing any of the speakers of the purpose of the study, the first author began by informally talking to about 30 individuals on and off campus about their linguistic backgrounds. From those 30 he identified 16 adult bilinguals whom he thought might be appropriate for this study and asked them to complete and return questionnaires. Fourteen were returned and the 10 speakers for this study were chosen from those 14. The speakers were volunteers and not a sample of the population at large. Most of the speakers had at least one university degree dealing with the study of language or language teaching.

Speech materials and procedures

All 10 speech samples were recorded using a Sony DAT Walkman tape recorder in a sound-treated room on the ICU campus. In 9 of 10 cases, the interviewer was the second author, a former graduate student of ICU; in one case the interviewer was a different (former) graduate student from ICU. Except for this one difference involving one interviewer, the 10 speakers were recorded under identical conditions.

Speakers' tasks included the reading of a randomized list of 22 Japanese words and a corresponding list of 22 English words. All words were monosyllabic and began with a single consonant onset (e.g., /b/ in "boat" and /k/

in "key"); 11 began with voiced stops (/b/, /d/, and /g/) to be used for a different study and 11 with voiceless stops (/p/, /t/, and /k/) to be used for this study. On both lists, of the words with voiceless stops to be used for this study, 3 words began with /p/, 3 with /t/, and 5 with /k/. Each speaker read each word 4 times. In all, 880 tokens (10 speakers x 44 tokens x 2 languages) were examined; of these 880, only 2 (one involving a voiceless vowel and the other a performance error) could not be measured and are not included in the results reported here.

We intended our Japanese word list and the procedures for reading it to replicate the experiment by Shimizu (1996) referred to above. In his experiment each Japanese word was read 4 times in the Japanese carrier phrase, *Kore wa __ desu*. The English word list was constructed to be, as much as possible, a similar and parallel English counterpart to the Japanese list. It also involved for each speaker a maximum of 44 voiceless tokens (11 words x 4 times). Each English word was uttered in the carrier phrase, "And I say __."

It is known that context may affect VOT. Lisker and Abramson (1967) found that the VOT of a stop may vary depending on whether the stop appears in a citation form or in running speech, and whether it appears in a stressed syllable or an unstressed one. They also found variation related to the syllable (e.g., initial or final) in which the stop appears in polysyllabic words, and related to the position in the sentence (e.g., in the beginning word or final word) in which the stop appears in sentences. It is also known that speaking rate may affect VOT (Kessinger & Blumstin, 1987). To help control for all this variance, and following Shimizu (1996), we used only word-initial singleton stops in monosyllabic words that were read from a list in isolation as citation forms (and were therefore stressed).

Additionally, we recognized (from Klatt, 1975) that VOT varied according to the following vowel environment (i.e., high vowels are related to longer VOT). Our study, replicating Shimizu's, involved in the Japanese list the 5 Japanese vowels (/a, i, u, e, o/). In designing the English list, we tried to select English words that contained vowels that were similar in height to the Japanese vowels. For the Japanese word for "tree," *ki* (/ki/), for example, the English word, "key" (/ki/) was selected as a counterpart. A few words on both the Japanese and the English list were nonsense words and speakers were alerted to this before they were asked to read the lists.

All words were digitized at 22.05 kHz with 16-bit resolution, then normalized for peak intensity. The VOT measurements were made from spectrograms (using *Cool Edit*: Phoenix, AZ: Syntrillium Software Corporation).

Before the actual measurements began, we two authors randomly selected and independently measured a number of tokens and compared our measurements. Each of us measured from the beginning of the release burst to the onset of periodicity of the following vowel. In several cases our measurements differed, but in almost all cases it was only a matter of where to begin the measurement of the first waveform (typically involving a 2 to 3 millisecond difference between our two measurements). We subsequently met with an outside consultant who had a Ph.D. in acoustic phonetics from the University of Hawaii in order to discuss and confirm a standard procedure for conducting the measurements. After this consultation and our agreement to base all measurements of VOT from the onset of the burst to the first zero crossing of the first periodic waveform, the second author measured all of the tokens. (A future stage of this project will investigate and report the interrater reliability of these measurements.)

Results and Discussion

In this paper we report both the individual and group results but discuss only the group results. Individual results require further analysis and will be addressed in a later stage of this project. The results are summarized in Table 2 and in Figure 1 based on Table 2. Table 2 shows the results of the 5 NE speakers at the top of the table and the results of the 5 NJ speakers at the bottom of the table. To the right of each of the 10 speakers are the results for the 3 English stops and then to the right of that are the results for the 3 Japanese stops.

For each NE speaker each number under /p/ is the mean based on the measurements of 12 tokens (3 words x 4 times); each number under /t/ is based on 12 tokens (3 words x 4 times); and each number under /k/ on 20 tokens (5 words x 4 times). Below that the group mean scores for English and Japanese /p/, /t/, and /k/ are given. For /p/ this mean is based on 60 tokens (12 tokens x 5 speakers), for /t/ on 60 tokens (12 tokens x 5 speakers), and for /k/ on 98 tokens (20 tokens x 5 speakers, minus 2 tokens that could not be measured). In the lower half of Table 2 the NJ speakers' results are provided and based on the same parameters as those of the NE speakers' just explained, except that for the native Japanese speakers all 100 tokens of /k/ were measured.

One notes in Table 2 that for the individual NE speakers, in 15 of 15 cases, the English VOT values are higher than the corresponding Japanese VOT values (e.g., for speaker NE1, English /p/ had a higher VOT than Japanese /p/). For the individual NJ speakers, in 14 of 15 cases, the English values are higher than the corresponding Japanese values. (The exception is speaker NJ6 for /p/.) In 6 of 6 cases, the mean VOT of the NE speaker group was higher that that of the NJ group. These 6 paired mean values form the basis for Figure 1, which makes two points clear: (1) Both groups of speakers (based on their group means) distinguish the diaphones in the two languages (e.g., English /p/ and Japanese /p/. (2) The two groups of speakers produce the same stop with different VOT values. For example, the NE speakers had VOT values for English /p/ and Japanese /p/ of 71.1 and 54.6, respectively; the NJ speaker VOT values for English /p/ and Japanese /p/ were 48.6 and 37.0, respectively.

To summarize: (1) The NE group mean was higher than the NJ group mean in 6 of 6 cases involving target /p/, /t/, and /k/. (2) The VOT of the English stops (regardless of speaker group, NE or NJ) was higher than that of the corresponding Japanese stops also in 6 of 6 cases.

TABLE 2

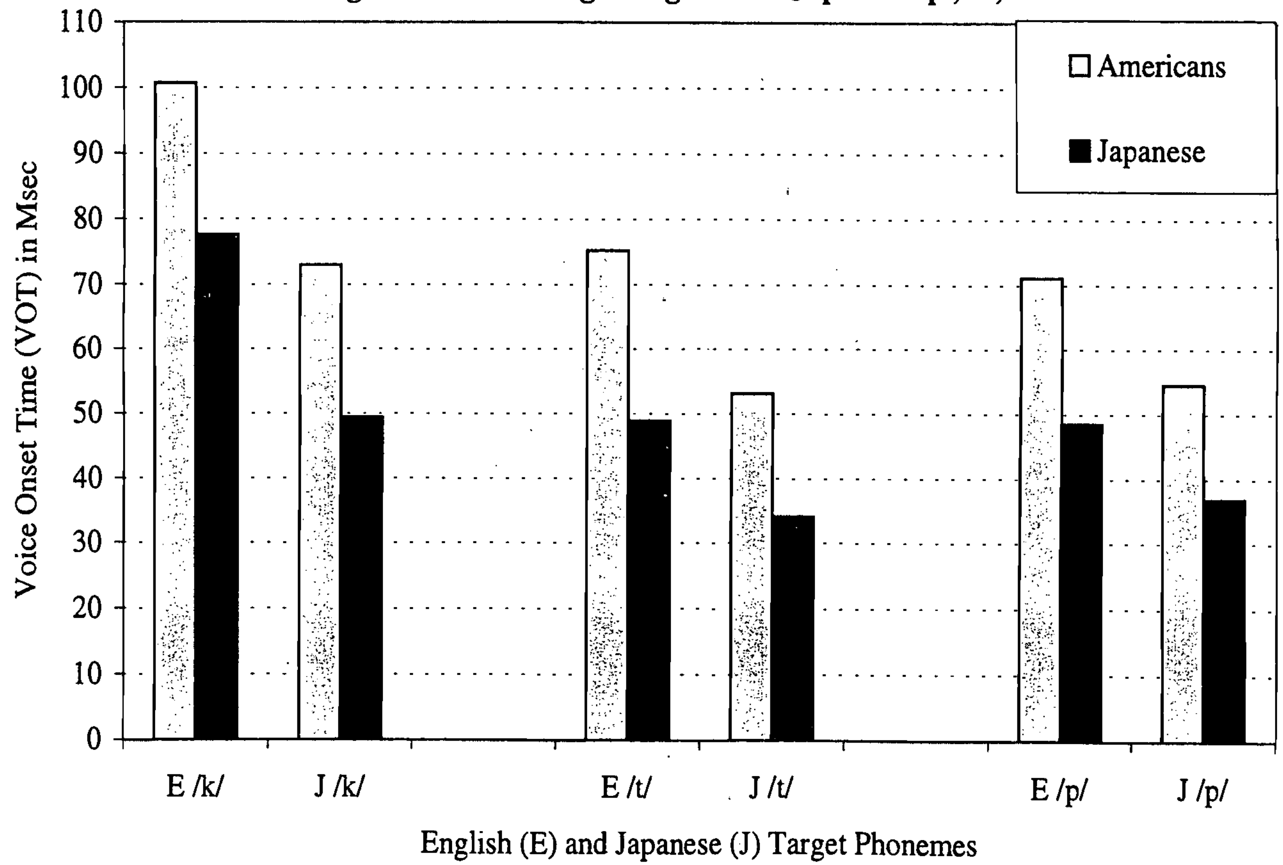
Native English (NE) Bilingual and Native Japanese (NJ) Bilingual VOT for Target English and Japanese Diaphones, /p/, /t/, and /k/

	English stops			Japanese stops		
	/p/	/t/	/k/	/p/	/t/	/k/
NE bilinguals						
NE1	70.6	85.1	108.2	57.4	56.3	76.3
NE2	83.4	76.8	105.0	59.9	64.3	76.1
NE3	80.5	73.8	110.1	63.2	49.3	75.6
NE4	53.5	56.0	81.3	44.8	45.2	69.0
NE5	67.5	84.5	98.9	47.4	51.0	67.6
NE group mean	71.1	75.2	100.7	54.6	53.2	72.9
NJ bilinguals						
NJ6	33.1	33.9	69.0	35.4	25.4	42.5
NJ7	42.8	45.5	82.7	38.3	43.9	59.5
NJ8	56.4	60.9	85.3	40.0	38.2	54.9
NJ9	57.9	55.7	74.8	45.4	43.8	46.0
NJ10	52.8	48.4	76.0	25.8	19.8	43.9
NJ group mean	48.6	48.9	77.5	37.0	34.2	49.4

We will now examine the results with respect to the four hypotheses posed above. Hypothesis 1 was that, as a group, the NE bilinguals would produce English stops with VOT values that are normal English values. Recall that "normal" here is referenced to Lisker and Abramson (1964). For the NE speakers the English VOT values somewhat approximated those of Lisker and Abramson (1964) shown in Table 1. They reported 58.0 for /p/, whereas we had 71.1; for /t/ they reported 70 and we had 75.2, and for /k/ they reported 80 and we had 100.7. Our results were consistently higher than those of Lisker and Abramson, but, as was pointed out above, we did not use the same word list that they did. Our VOT values, nonetheless, fall well within the range commonly

FIGURE 1

Native English (NE, n=5) Bilingual and Native Japanese (NJ, n=5) Bilingual VOT for Target English and Japanese /p/, /t/, and /k/



reported for English VOT, and there is no evidence that the NE bilinguals changed their L1 values. (If we had predicted any change, we would have predicted that the NE speakers L1 English values would have been *lower*, in accordance with possibility (3) above.) We interpret this as general support for Hypothesis 1, and no support for the suggestion reported earlier by Flege (1995) that the L1 phonetic category established in childhood may evolve gradually if it is linked perceptually to an L2 sound.

Hypothesis 2 was that as a group the NJ bilinguals would produce Japanese stops with VOT values that are normal Japanese values. For Japanese, recall that we used the same word list as Shimizu (1996). He reported 41 for /p/ and we had 37.0; he reported 30 for /t/ and we had 34.2; he reported 66 for /k/ and we had 49.4. Our values are neither long lag nor short lag but intermediate and fall well within the range reported by Shimizu. There is no evidence that the NJ speakers have changed their L1 values as a result of becoming bilingual. We interpret this as support for Hypothesis 2, and no support for the suggestion by Flege (1995) that the L1 phonetic category established in childhood may evolve gradually if it is linked perceptually to an L2 sound. (Unfortunately, as we pointed out above, we are aware of no studies of VOT in monolingual Japanese that we may refer to. Thus we had no recourse but to refer to Shimizu's bilingual speakers and assume that they also represent monolingual values.)

Hypothesis 3 was that as a group the NE bilinguals would produce Japanese stops with VOT values that are positioned between normal NE values and normal NJ values. This hypothesis was supported. The NE speakers as a group produced a VOT value for Japanese /p/ of 54.6 and this was positioned between the NE group English mean for /p/ of 71.1 and the NJ group mean for Japanese /p/ of 37.0. The NE speakers as a group produced a VOT value for Japanese /t/ of 53.2 and this was positioned between the NE group English mean for /t/ of 75.2 and the NJ group mean for Japanese /t/ of 34.2. The NE speakers as a group produced a VOT value for Japanese /k/ of 72.9 and this was positioned between the NE group English mean for /k/ of 100.7 and the NJ group mean for Japanese /k/ of 49.4.

Hypothesis 4 was that as a group the NJ bilinguals would produce English stops with VOT values that are positioned between normal NJ values and normal NE values. This hypothesis was also supported. The NJ speakers as a group produced a mean VOT value for English /p/ of 48.6, positioned between their mean VOT for Japanese /p/ of 37.0 and the NE group mean for English /p/ of 71.1. The NJ speakers as a group produced a mean VOT value for English /t/ of 48.9, positioned between their mean VOT for Japanese /t/ of 34.2 and the NE group mean for English /t/ of 75.2. The NJ speakers as a group produced a mean VOT value for English /k/ of 77.5, positioned between their mean VOT for Japanese /k/ of 49.4 and the NE group mean for English /k/ of 100.7.

Thus, on the basis of the evidence presented above, Hypotheses 2, 3, and 4 were supported. Regarding Hypothesis 1, the support was less robust; the NE speaker VOT values in English in our project were different from those reported by Lisker and Abramson (1964) but this might have been due to the fact that the two studies, theirs and ours, used a different word list.

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