PERCEPTION AND PRODUCTION OF A VOICING CONTRAST BY FRENCH-ENGLISH BILINGUALS

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ABSTRACT

The use of F1 onset information, which constitutes a cue to the voicing contrast in English, but not in French, was investigated in French-English bilinguals, classified according language bias. Results show evidence of code-switching in production but not in perception. English-bias bilinguals were more strongly affected by the F1 onset cue than French-bias bilinguals.

1. INTRODUCTION

Perceptual studies with bilinguals investigate whether phonemic categorisation is affected by higher order linguistic information, by presenting a same continuum with different language precursors. The voicing contrast is particularly useful for such investigations, as it is marked differently along the Voice Onset Time (VOT) dimension in languages such as French and English. Results of such studies are contradictory. Some have not found evidence of any language effect on categorisation (eg. [1]) while others have only found evidence of code switching in perception for strong bilinguals [2]. In this study, the effect of language bias was controlled by testing bilinguals both in France and in Great-Britain. Computer-edited natural stimuli were used together with careful test procedures to ensure that subjects were sufficiently induced into a particular language set.

A novel approach was to focus attention on the use by French-English bilingual and monolingual subjects of spectral cues to the voicing contrast. In English, first formant cutback in the vowel following long-lag voiceless plosives contrasts with a rising first formant onset following short-lag voiced plosives while, in French, a rising first formant onset is present after both voiced (lead) and voiceless (short-lag) plosives. F1 onset therefore constitutes an additional cue to the voicing contrast in English but not in French.

2. STIMULI

The /pen/-/ben/ minimal pair was chosen as it is meaningful both in English ("Ben - pen") and in French ("benne - penne"). Test continua were created using digitised natural speech waveforms. In all continua, VOT ranged from -40 ms to +40 ms in 10 ms steps. In the first continuum (Pen/VOT), the [en] portion, burst transient and aspiration were taken from a voiceless [p^{h}en] produced by a male speaker. A "cut and paste" technique was used to create intermediate stimuli. For stimuli with positive VOTs, the aspiration was progressively deleted, in 10 ms slices, following the burst release. For stimuli with negative VOTs, the prevoiced portion was edited out of a voiced [ben], appended to the front of the burst release then cut back in 10 ms steps. In the second continuum (Ben/VOT), the [en] portion from a [ben] token was used. The

same technique as described above was used to obtain the VOT continuum. The two ranges therefore varied in the spectral characteristics of the vowel. In order to create French and English test conditions, each of the stimuli described above was preceded by a precursor: "répète" in the French condition and "repeat" in the English condition. For each condition, an identification test tape was prepared by randomizing and recording ten tokens of each of the nine stimuli.

3. SUBJECTS

Four groups of listeners were tested: 8 bilinguals living in London, 13 bilinguals living in Paris, 11 British monolinguals and 13 French monolinguals. All subjects reported normal hearing.

4. PROCEDURE

Testing was carried out over two one-hour sessions on separate days (one session only for monolinguals). At each session, only one language was used. The session started with a speech recording of "accent-revealing" sentences and of minimal pairs. The Pen/VOT and Ben/VOT stimuli were then presented in two-alternative forced-choice identification tests. Stimuli were presented free-field at a comfortable listening level.

5. RESULTS

5.1 Classification of subjects

Bilingual subjects were classified according to strength of bilingualism and language bias. Strength of bilingualism classification was based on judgments by phonetically trained listeners in France and Great-Britain of the recordings of the "accent-revealing" sentences on a scale of 0 (native) to 5 (foreign). Language bias, seeking to reflect what would be considered the "base language" for a particular bilingual, was determined on the basis of a questionnaire where information was collected on main language spoken with family and friends, at school, etc. There were 10 English-bias bilinguals (4 "mid" and 6 "strong") and 11 French-bias bilinguals (4 "mid" and 7 "strong").

5.2 Production

VOT measurements were made of five repetitions of /pen/ and /ben/ for each speaker in each language. Means were then obtained according to subject group and language mode (Fig. 1). There is clear evidence of code switching in production, even though values obtained for bilinguals differ from monolingual values. The mean values obtained for "mid" bilinguals in their weaker language were furthest from the average monolingual values.

5.3 Perception

Mean labelling functions obtained for monolinguals and for bilinguals grouped according to language bias are presented in Figure 2. The mean phoneme boundary estimates were obtained using a maximum likelihood estimation technique, which fits a cumulative normal function to the data. For the Ben/VOT condition, mean boundary values of +1.4 ms were obtained for French monolinguals and +17.6 ms for English monolinguals. A sizeable phoneme boundary shift was obtained in the Pen/VOT condition for both groups of monolinguals with boundaries of -10.6 ms for English subjects and -22.4 ms for French subjects. Even though F1 onset is not contrastive in French, the presence of "abnormal" spectral characteristics therefore led to a greater proportion of voiceless responses by French listeners with only stimuli with greater than 20 ms of prevoicing consistently labelled as voiced. The labelling function obtained for English monolinguals was less sharp; even stimuli with prevoicing were not consistently labelled as voiced.

For the bilingual groups, each

graph contains four functions representing the labelling of the Pen/VOT and Ben/VOT conditions with French and English precursors. Phoneme boundaries (Table I) obtained for the Ben/VOT condition were similar for the French- and English-bias bilingual groups and intermediate to values obtained for monolingual listeners. There was little evidence of a significant shift in boundary between French- and English-precursor conditions as the 95% confidence interval ranges overlap considerably. For the Pen/VOT condition, English-bias listeners showed a much greater boundary shift relative to the Ben/VOT condition than French-bias listeners. As French monolinguals, French-bias bilinguals were able to consistently label stimuli with greater than 20 ms prevoicing as voiced despite conflicting spectral cues in the vowel. However, their labelling of the continuum was much less categorical than that obtained for monolinguals. Again, for both groups there was little evidence of boundary shift induced by a difference in the language of the precursor.

6. DISCUSSION

There is clear evidence of code-switching in production. The effect of strength of bilingualism was seen as weaker bilinguals showed a less complete shift in VOT between their productions of the French and English contrasts than stronger bilinguals. In perception, little evidence was found to support code-switching. On average, changing the language of the precursor did not generally lead to a significant shift in phoneme boundary, although evidence of code-switching may be found for individual bilinguals. A change in the spectral characteristics at vowel onset did however have a differential effect on labelling according to language bias. There is therefore some evidence for the theory that bilinguals have a "base language" which determines which speech pattern cues are used in perception. Indeed, bilinguals exposed to English early were shown to be more sensitive to changes in spectral characteristics of the vowel and showed this sensitivity both in French and English modes. Further support for a "base" language in bilinguals can be found at a different level of processing. Indeed, Cutler et al. [3] found that only French-dominant bilinguals made use of syllabic segmentation, which is appropriate for French but not English, even though all subjects in the study were strong bilinguals. There is therefore evidence from different sources that even in highly proficient bilinguals, one language dominates in terms of certain aspects of language processing.

7. REFERENCES

[1] WILLIAMS, L . (1977) "The perception of stop consonant voicing by Spanish-English bilinguals", *Perception and Psychophysics, 21*, 289-297.

[2] ELMAN, J.L., DIEHL, R.L. & BUCHWALD, S.E. (1977) "Perceptual switching in bilinguals", *J. Acoust. Soc. Am., 62*, 971-974.

[3] CUTLER, A., MEHLER, J., NORRIS, D., SEGUI, J. (1989) "Limits on bilingualism", *Nature*.

Table I: Phoneme boundary measures (ms VOT)

	Mean	95% conf.int.
FRENCH-BIAS BILINGUALS		
Ben/VOT E	11.5	6.9 → 15.9
Ben/VOT F	7.7	2.6 → 12.9
Pen/VOT E	-9.8	-15.8 → -3.8
Pen/VOT F	-14.7	-17.9 → -11.5
ENGLISH-BIAS BILINGUALS		
Ben/VOT E	8.0	* *
Ben/VOT F	9.7	-1.2 → 19.4
Pen/VOT E	-20.4	-32.2 → -12.1
Pen/VOT F	-21.4	-27.5 → -16.5

* not estimable

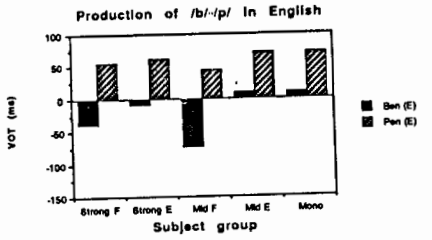

Figure 1: Mean VOT measurements for productions of /pen/ and /ben/ by monolingual speakers and bilingual speakers in each language.

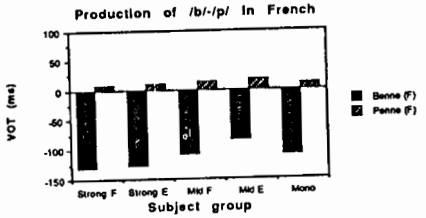

Figure 2: Mean labelling functions for monolinguals and bilinguals grouped according to language bias.