THE EFFECT OF BILINGUALISM ON THE ACQUISITION OF PERCEPTUAL CATEGORIES UNDERLYING THE VOICING CONTRAST

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ABSTRACT

A perceptual experiment was conducted to determine whether bilingual children's development of the categories underlying the voicing contrast resembled that of monolingual control groups. The bilinguals showed a clear difference in their perceptions across the two languages. However, their categorization was not identical to that of the controls, showing interference, especially from the language spoken in their country of residence.

1. INTRODUCTION

A developing field of inquiry concerns the extent to which bilinguals are able to maintain strict separation between their processing strategies in their two languages. It has recently been claimed by Cutler *et al.* [1] that English-French bilinguals have only one speech segmentation strategy, that of their dominant language. With respect to the well-known cross-linguistic differences in the perception of the voicing contrast ([2]), bilinguals can show a language-based difference in categorization ([3], [4]). However, the effect is generally much smaller than has been found when comparing monolingual speakers of the relevant languages. Very little is known of the development of perception categories in bilinguals and the existing literature is largely concerned with secondary bilinguals (see, e.g. [5]). As shown by Simon and Fourcin [6], the ages between 4 and 10 involve a gradual development of adult-like perceptual responses, at least as shown by experiments based on synthetic speech-like continua. This development is cross-linguistically heterogeneous. In English, children acquire the ability to respond in a sharply categorical fashion to a VOT continuum at the age of 5. The average 50% crossover point in their labelling functions is higher than that of adults and slowly diminishes towards the adult norm over the next 5 to 7 years. At about the age of 8, they become aware of the perceptual salience of variations in the onset frequency of F1, with higher values causing a downward shift in the VOT category boundary, corresponding to fewer voiced percepts. In French, sharply categorical labelling is not attained until the age of about 8 and the category boundary is much lower (between 0 and 10 ms) than for English (25 ms). The F1 cue is not found to be salient in French.

The present experiment uses VOT and F1 onset frequency parameters to compare English-French bilingual groups aged 6, 8 and 10 to monolinguals, both adult and child. There were two groups of bilinguals at each age, one resident in England, the other in France. The hypotheses to be tested were: (i) bilinguals would show a clear difference in their perceptual responses according to language; (ii) at each age studied the bilinguals would be identical to the monolingual control groups with respect both to their response to the VOT continuum and to manipulations in F1 onset frequency; (iii) the bilinguals would not differ according to their country of residence, and (iv) they would show, like the monolinguals, a clear progression towards adult norms in both languages.

2. METHOD

A perceptual identification experiment was designed based around two synthetic VOT continua. The first contained tokens in which VOT varied from -30 to +50 ms in 5 ms steps. The tokens were heard as 'gash' or 'cash' in English and as 'gâche' or 'cache' in French. This continuum (henceforth the "normal"continuum) was used to investigate VOT categorization. The second continuum differed from the first in that the F1 onset frequency was held artificially high at a frequency of 685 Hz in short-lag tokens (with VOTs up to 40 ms). This was used in comparison to the normal continuum to assess responsiveness to a high F1 onset frequency. The continua were produced with each of two carrier phrases, one being the English "I say..." and the other, the French "Je dis...". For each continuum, each group of carrier plus token was recorded onto a tape recorder a total of 6 times with 3 seconds between the tokens.

Both monolingual and bilingual subjects were resident in Paris or London. The bilinguals had been exposed to both languages in the home from birth and at schools specifically for bilinguals. The adult monolinguals had had at least some schooling in their non-native language but did not considered themselves proficient in that language. The younger monolinguals had no knowledge of languages other that their mother tongue.

Subjects indicated their responses to the perceptual test by ticking the appropriate box under pictures which illustrated the target words. Bilinguals performed the experiment once in each language, the order of presentation being varied.

The resulting data were grouped to give overall identification curves for each subject group. These curves were then subject to logit analysis using the GLIM General Linear Models package.

3. RESULTS

The results are presented in Tables 1. and 2. Table 1. presents the mean values for the 50% - crossover points for each group for the normal continuum. Table 2. shows the effect of the F1 onset frequency manipulation in terms of the shift it produced in the group category boundary relative to the normal continuum. This style of presentation has been used due to limitations of space, rather then the traditional representations of identification curves. However, it must be borne in mind that it is the overall curves and not just the crossover points abstracted from them which formed the basis of the statistical processing. A difference of, for example, 3 ms difference in crossover point between the two continua may represent a significant shift in response curve in some cases, but not others.

3.1 Cross-linguistic comparison of bilinguals

It will be clear from Table 1. that all bilingual groups at all ages responded differently to the normal continua in the English and French conditions. The expected outcome was obtained of a lower cross-over point in French than in English. In all cases, the difference is highly significant ($p < 0.005$). There was also a strong tendency for the labelling functions to be less sharply categorical in French than in English .

Table 1. Mean VOT 50%-crossover values for normal continuum

a)

6 yr olds	English		French	
E. bilings		21.5	15.5	
Mono	25			8*
F. bilings		20	8.5	

b)

8 yr olds	English		French	
E. bilings		22	16.5	
Mono	22.5			-3
F. bilings		20	12	

c)

10 yr olds	English		French	
E. bilings		19	14.5	
Mono	21.5			10
F. bilings		17	11	

d)

Group	English		French	
Adult Mono	18.5			5*

N.B. * indicates non-monotonic function with more than one 50% - crossover point

3.2 Distinction between bilingual and monolingual groups

Contrary to the hypothesis in section 1, in most cases there are significant differences between bilinguals and the relevant control groups with respect to their categorization of the normal continuum. In all cases, these differences result from a greater similarity between the response curves of the bilinguals response curves being more similar than between those of the monolinguals.

Amongst the 6 year olds, the bilinguals resident in England differ to a statistically significant extent (here and in all further cases, $p < 0.01$) from both of their monolingual peer groups. The Paris-based bilinguals are dramatically different from the English control group but indistinguishable from their French

peers, (even though the French monolingual group has a non-monotonic labelling function with crossovers at both -0.5 and +8 ms.)

In contrast, the 8 year old Paris-based bilinguals responses differ significantly from those of both their French and English contemporaries. The London-based 8 year old bilinguals differ from the monolinguals in their French, but not their English labelling functions.

For the 10 year olds, the same pattern obtains as for the 8 year olds, that is, the bilingual results differ significantly from the monolinguals, except in the case of the London-based monolinguals' English responses.

There is thus a general pattern of difference between the bilinguals and monolingual control groups, although the older child subjects living in England produce results in line with their English monolingual counterparts.

The results for the F1 manipulation, are shown in Table 2., expressed as the shift (in ms) of the category boundary produced by the second (high F1) VOT continuum relative to the first.

Table 2. Shift for F1 manipulation

a)

6 yr olds	English		French	
E. bilings		1.5	**20**	
Mono	1.5!			3.5!
F. bilings		2.5	8.5	

b)

8 yr olds	English		French	
E. bilings		2	2	
Mono	**4**			0
F. bilings		**4**	0.5	

c)

10 yr olds	English		French	
E. bilings		**2**	1.5	
Mono	**3.5**			**7**
F bilings		0.5	1	

d)

Group	English		French
Adult Mono	**2**		**3.5!**

N.B. ! indicates a shift in the opposite direction to that predicted, i.e. an increase in /g/-reponses. Figures in bold indicate a shift which is statistically significant ($p < 0.01$).

The bilinguals depart from the monolinguals in a number of ways. However, these departures are no consistent, and the monolinguals themselves produce more heterogeneous results than those of Simon and Fourcin [6]. In general, there is a small movement of the category boundary in English. This is significant for the 8 and 10 year old monolingual groups, for the Parisian 8 year old bilingual group and for the 10 year old London-based bilingual group. None of the 6 year old groups show significant effects, nor do the Paris based 10 year old bilinguals.

In French, it will be recalled, no effect of the F1 manipulation is expected. In fact, responses vary dramatically from group to group. Most of the observed differences are insignificant and some bilingual groups which responded to this cue in English failed to do so in French. Nevertheless, there are some significant shifts of category boundary in French. The most dramatic is that of the 6 year old London-based bilinguals (20 ms) but the 6 year old Paris-based bilinguals and the 10 year old French monolinguals also show sizeable shifts of 8.5 and 7 ms respectively. The monolinguals' result argues against any straightforward account of these findings in terms of language contact. The bilingual subjects might be transferring perceptual skills from English to French. However, if subjects with no knowledge of English exhibit the same behaviour, such transfer cannot be the only available explanation.

No clear patterns emerge, therefore, from the F1 manipulation. In general, the F1 cue is used by the older children in English but not French, and bilinguals are capable of using it in one language, but not the other. However, the contrast between the two languages is less stark than earlier studies had suggested.

3.3 Differences between bilingual groups

Although the differences in category boundary between the bilingual groups are frequently small in terms of milliseconds, they are nevertheless all statistically significant. The effect is apparently related to the language of the country of residence dominating the other. Thus, London-based bilinguals always have higher category boundaries in both languages than Paris-based bilinguals. This difference does not appear to vary across the age groups.

3.4 Progression towards adult norms

As shown in Table 1., the 50% crossover for the English adult group is situated at 18.5 ms. The English monolingual groups do show a pattern of slow decrease in crossover values toward this figure, the age-based difference being significant ($p < 0.01$). There is a similar, and similarly significant, trend in both bilingual groups.

In French, there is no consistent pattern. The adult category boundary falls at +5 ms, although in this case, there is again a non-monotonic function with a crossover at -2.5 as well as +5 ms. There are statistically significant distinctionsbetween the different age groups, and between the children and tha adults, but no obvious developmental pattern emerges. Given that the adults do have a lower category boundary than most of the child groups, . it may be that adult-like values are attained at a later stage by French speakers than is encompassed in this experiment.

The majority of crossover points observed in French in this study lie in the region between +5 and +17 ms. This is a somewhat higher range than has been referred to in earlier literature ([6]) but it is consistent with data from a production study conducted with the same subjects. This shows that although the majority of voiced tokens in French are produced with pre-voicing, a substantial minority have VOT in the short-lag region.

4. DISCUSSION

Cutler et al ([1]) have shown that in some respects even strong bilinguals have a dominant language. The present study demonstrates that the same is not entirely true with respect to the voicing contrast.. All the bilingual groups showed a clear difference in identification functions dependant on the language they believed they were hearing. Furthermore, in several groups the F1 cue trading relation was in evidence in one language - English - but not the other, even thought the stimuli were identical in both cases. However, the disparities between the bilingual and monolingual groups, show that bilingualism does affect perceptual processing. Furthermore the different responses of the two bilingual groups indicate that even while they maintained different categories in their two languages, that spoken in their country of residence had the greater influence.

Despite these differences in detail, no clear differences in developmental pattern emerge between bilinguals and monolinguals. The youngest bilingual subjects dealt with here had already developed distinct perceptual categories in English and French. Those categories develop in a similar way to monolinguals in English (lowering of category boundary, development of F1 trading relation). In French, there is no such apparent development, but this is equally true for the monolinguals.

Bilingualism may modify the details of perceptual processing and its acquisition, but it is possible to be perceptually bilingual.

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