INFANT BILINGUALISM: ARE THERE TWO VOICING SYSTEMS?

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INFANT BILINGUALISM: ARE THERE TWO VOICING SYSTEMS?*

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Introduction

In what follows we shall be reporting on a pilot study from a small part of a research project we are conducting on the simultaneous acquisition of English and Spanish by a child aged between 1;3 and 3;3. The child is the daughter of the first author, and was aged 1;7 at the time of the pilot study. She is exposed to English in the creche where she goes daily and from her grandmother; and to Spanish from her parents when no monolingual English speakers are present. Her father is a native speaker of Latin American, Panamanian Spanish, while her mother is a fluent but non-native speaker of the same variety. The aim of the project is to investigate the implications of a case study of infant bilingualism for linguistic theory. We want to test some aspects of learnability theory, in particular, the nature of the relation between universal grammar (UG) and linguistic input. The project includes the study of both phonology and syntax, but in this paper we shall be reporting on a particular aspect of phonology, the voicing contrast, or, as we shall call it, the voicing parameter.

Universal grammar and bilingualism

First of all we need to explain the value of a bilingual acquisition study for examining the relation between UG and the linguistic input. According to Chomsky's formulation of government and binding theory, UG, which is equated with the language acquisition device (LAD), can be conceived of as a set of principles with certain 'open parameters'. These parameters are fixed or set by experience in the form of exposure to a particular language (see e.g. Chomsky 1981:38).

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If a particular language does not provide enough evidence to se parameter in a particular direction, the unmarked setting of th parameter will be chosen, this setting being determined by considerations of markedness and learnability. Parameters can as dimensions on which particular languages may vary. To give well-known example from syntax, English and Spanish differ on w known as the pro-drop parameter. Spanish is a pro-drop languag which means that pronouns in subject position may be deleted. the English utterance 'I see' can be translated into Spanish as 'yo veo' or 'veo' with the pronoun deleted, whereas in English cannot delete the first person pronoun. According to the theor child learning a language has to set the pro-drop parameter acc to the nature of the input, setting it as non-pro-drop if expos language like English, and pro-drop if a language like Spanish. value of a bilingual study for examining the nature of the relationship between input and universal grammar is based on t assumption that developing bilinguals show evidence of a single initial system, and that this system gradually divides into two assumption is fairly well supported by evidence from both phono and syntax (see e.g. Contreras and Saporta 1970, Vogel 1975, Vo and Taeschner 1978.) Insofar as the two languages being learne differ on identifiable parameters, predictions can be made abou unmarked setting of each parameter in the face of two contrasti sources of evidence, which, if presented to two separate childr monolingual acquisition, would lead to two contrasting outcomes

The voicing parameter

In this paper we want to test predictions we might make about t bilingual acquisition of what we shall call the voicing paramet in more familiar terms, the voicing contrast. Just as the notio parameters is useful in studying the acquisition of syntax, we that it may also be useful in studying the acquisition of phono assuming that phonology, like syntax, is part of universal gra The voicing contrast seems to be a good candidate for a paramet found in universal grammar because it appears to be used in mos

languages of the world as a distinctive feature, and yet the phonetic basis for the contrast varies from language to language. Furthermore, the idea that knowledge of the voicing contrast is in some sense innate is arguably" supported by the finding that very young infants perceive voiced and voiceless stops in ways which appear to correspond to adult phonemic categories (see e.g. Eimas et al 1971, Jusczyk 1974).

Thus we hypothesize that the child comes to the language learning task with the assumption that there is such a thing as a voicing parameter, but that it has to be set according to the nature of the input language. English and Spanish are useful languages for studying the acquisition of the voicing parameter, since they differ in the way the voicing contrast is realized, or in the way this parameter is 'set'. Since languages have various ways of setting the voicing parameter, a theoretically interesting question is what would be the unmarked or neutral setting of the parameter. A bilingual acquisition study may help us to answer this question, since if there is indeed a single initial system, we might expect it to represent the unmarked setting.

In the pilot study to be described we focus on the acquisition of voicing in initial stops: this restriction has the methodological advantage that word-initial stops occur in the earliest utterances.

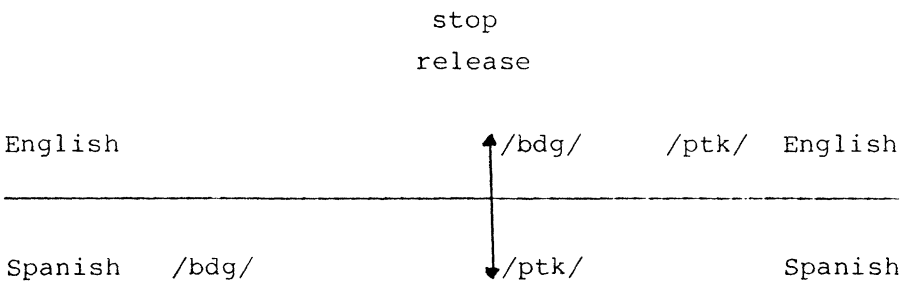
Voicing systems in Spanish and English

In a cross-language study of voicing in initial stops, Lisker and Abramson (1964) isolated three categories stops according to different voice onset times. These categories were labelled voicing lead, short voicing lag and long voicing lag, and are illustrated in Figure 1 (in the appendix) from Lisker and Abramson (1964). In each case voice onset time (VOT) is based on the time interval between the release of the stop and the onset of glottal vibration. On the spectrogram, the release was identified at the point where the pattern showed an abrupt change in the overall spectrum, and voice onset was identified at the point where the first of the regularly spaced vertical striations could be taken to indicate glottal pulsing. In the first category illustrated in Figure 1, there is a negative voice onset time because

glottal vibration begins before the release. This is what is called voicing lead. In the other two categories voicing begins after the release, but sooner in the second category (short lag) than in the third (long lag). Lisker and Abramson found that the eleven languages they studied all made use of two or more of these three categories of stops. English and Spanish both made use of two categories, but not the same two. While the contrast in English was based on the difference between short and long lag stops, that in Spanish was based on the difference between short lag and voicing lead stops. Lisker and Abramson's measurements of average VOT for word-initial stops in English and Spanish are shown in Table 1 below together with a diagram to make the relation between English and Spanish stops clearer.

TABLE 1: LISKER AND ABRAMSON'S MEASUREMENTS OF VOT (IN AVERAGE MSECS) IN WORD-INITIAL STOPS

	English	Spanish
/b/	1	-138
/p/	58	4
/d/	5	-110
/t/	70	9
/g/	21	-108
/k/	80	29



As you can see from the diagram, the voiced stops in English occupy roughly the same phonetic space as the voiceless stops in Spanish. We may ask what system the child will learn initially, whether English or

Spanish or something different.

Previous research on the acquisition of voicing in English and Spanish«

We know of no previous studies on the bilingual acquisition of voicing in English and Spanish, but there is some useful evidence from monolingual acquisition studies of the two languages. Macken and Barton (1979) found in their study of infants acquiring American English that the children went through three stages towards acquiring a voicing system similar to the adult contrast between short and long lag stops. The stages were as follows:

(1) child has no contrast;

(2) child has a contrast falling within or close to the boundaries of one adult phoneme;

(3) child has a contrast which resembles adult contrast. (See Macken and Barton 1980:451).

However, in their study of infants acquiring Mexican Spanish (Macken and Barton 1980) they found that although the first stage of acquisition was identical to that found in the English study, subsequent stages showed that the voicing contrast was not based on differences of VOT, but on a contrast between short lag stops and continuants. They attributed this to the prevalence of spirants in place of voiced or voicing lead stops in the linguistic input, some of which were predicted by the standard allophonic rule for spirantization, but some of which were not. The standard rule for spirantization as given by Macken and Barton (1980:451) is shown below.

$$/bdg/ \rightarrow [-cont] / \left\{ \begin{array}{l} \underline{\quad} \\ N\#\underline{\quad} \\ l\#d \end{array} \right\}$$

/bdg/~>[+cont] elsewhere

The relevant aspect of this rule for us is that word-initial stop realized as stops in utterance-initial position, but otherwise as continuants. However when Macken and Barton analysed their lingi input they found that in 30%-40% of the phonological environments stops would have been expected, i.e. utterance-initial position, spirants were actually produced. They concluded that the phonolc the adult system needed to be re-examined, and that "Further res* needs to be done to resolve the issue of the learnability of lea< other VOT/voicing types and to determine the role that allophony during acquisition' (Macken and Barton 1980, p. 457)

Some further research was in fact done by Eilers et al (1984) wh< obtained results for Spanish quite different from those found by and Barton. In a study comparing the production of VOT in stop consonants in two year old monolingual English and monolingual S; learners, they found evidence that both had adult-like VOT contr that in the English learners being based on short versus long la stops, and that in the Spanish learners on lead voicing versus s lag stops. They found no examples of spirants for stops among t Spanish learners. They admit that their data was different from and Barton's in that they used imitations of meaningless syllabi rather than spontaneous speech, but their children's ability to lead voicing as distinct from short lag stops still has to be explained•

However, it seems to us that the results of the two studies are entirely incompatible in that in both cases a voicing distinctic realized, and in both cases this could be described as earlier \ later voicing. This distinction is clear in the Eilers et al sti where the contrast was lead versus short lag (Spanish) or short long lag (English). In the Macken and Barton study the distinct English was the same as in the Eilers et al study (short versus lag), while in Spanish the distinction could be described as eai versus late voicing onset. (This assumes that the continuants \ replaced voiced stops were themselves voiced, as appears to be 1 case.) Voiced continuants have early voicing onset by definiti< since there is no closure. This distinction between early and

voicing onset is also a useful general way of describing both lead versus lag and short versus long lag. In all cases the voiced phoneme has early voice onset, while the voiceless phoneme has later voice onset.

Predictions for case study

In the case study in question, we are now interested in predicting the nature of the voicing contrast in the single initial system, assuming that it is indeed undifferentiated. We note that the results from monolingual acquisition have in common the development of an early versus late voice onset contrast in stop phonemes. So if there is a single initial system in a child acquiring English and Spanish simultaneously, we might expect this system to reflect the same generalisation. Thus we would predict the following stages of acquisition:

(1) No significant VOT contrast in words from either language having clear initial stops, but stops being predominantly short lag;
(2) A single voicing contrast developing on the basis of early versus late voicing onset for voiced versus voiceless consonants;
(3) As the languages separate, voicing systems approach those of the adult languages.

If these predictions are correct we might then be able to describe the voicing parameter as allowing a range of options to establish a contrast between early and later voicing. The exact nature and timing of the terms of the contrast would then be determined by the specific input language.

Pilot study

A pilot study was done to investigate the nature of the voicing system in tokens of word-initial stops collected in two recording sessions when the child was aged 1;7. In one session the child was interacting with a Spanish-speaking and an English-speaking interlocutor. All words selected for study had a clear Spanish or English source word beginning with a stop. A computer speech analysis package was used to generate spectrograms and wave forms of each token. Where a release

could be identified on the spectrograms, voice onset time was measured as the interval between the release and voice onset using Lisker and Abramson's criteria mentioned on p.3. The wave form was used as a check on the points selected for measurement. Where no release could be detected, or the spectrogram indicated a large amount of noise, the token was discarded. In the end, the number of tokens where VOT could be measured was not high, and was unevenly distributed between source languages as well as between places of articulation. There were 12 tokens with an English source and 17 tokens with a Spanish source. A summary of the results is presented in Tables 2 and 3 below.

TABLE 2: RESULTS OF VOT MEASUREMENTS (ENGLISH SOURCE WORDS)

Stop	Tokens	Mean VOT	VOT range
/p/	0	-	-
/b/	5	18 msec	0-39msec
/t/	1	35 msec	-
/d/	1	31 msec	-
/k/	4	29 msec	14-41msec
/g/	1	16 msec	-

Source words: book, brick, bucket, tired, dinner, clock, granny

TABLE 3: RESULTS OF VOT MEASUREMENTS (SPANISH SOURCE WORDS)

Stop	Tokens	Mean VOT	VOT range
/p/	8	16 msec	0-43msec
/b/	0	-	-
/t/	0	-	-
/d/	1	17 msec	-
/k/	2	36 msec	35-37msec
/g/	6	32 msec	15-55msec

Source words: pan, papa, dos, cama, galleta, gato.

As the number of tokens is very small, firm conclusions would be

premature. However, no pattern emerges which would indicate a difference between the VOT of voiced and voiceless consonants for either English or Spanish. (The pattern was similar when the words were divided according to Spanish versus English-speaking interlocutor.) This lack of distinction between voiced and voiceless stops according to VOT is shown more clearly in Table 4, where VOT measurements are pooled from all sources: English, Spanish and ambiguous. The ambiguous source words were as follows: baby/bebe, ball/bola, teddy, train/tren. (Teddy was used by both the English-speaking and the Spanish-speaking interlocutors.)

TABLE 4: RESULTS OF VOT MEASUREMENTS (ALL SOURCES)

Stop	Tokens	Mean VOT	VOT range
/p/	8	16 msec	0-43msec
/b/	12	25 msec	0-45msec
/t/	4	27 msec	8-39msec
/d/	2	24 msec	17-31msec
/k/	6	31 msec	14-41msec
/g/	7	30 msec	15-55msec

Table 4 shows quite clearly that the VOT measurements for voiced and voiceless phonemes are similar. Furthermore, in Table 4 as in Tables 2 and 3, all average VOT measurements are in the short lag range (taken by Macken and Barton 1979 to be 0-40msec for velar stops, 0-20msec for the rest) or close to it. So the results are quite consistent with our predicted stage 1.

Given the predominance of continuants in Macken and Barton's Spanish monolingual study, we also checked the transcripts of all words with initial stops in source languages to see what proportion, if any, showed continuants. In this analysis all the words from the transcribed sessions were checked including those with an ambiguous source. These were words where the possible source word in English an

Spanish was similar e.g. words derived from 'baby' or 'bebe'. The results are shown in Table 5 below.

TABLE 5: CONTINUANTS AS A FRACTION OF TOTAL TOKENS OF INITIAL STOPS IN SOURCE LANGUAGE

Stop	Continuants/total			
	Source			
	English	Spanish	Ambiguous	All sources
/p/	-	1/17	-	1/17
/b/	4/9	-	5/11	9/20
/t/	0/1	-	0/3	0/4
/d/	0/2	0/3	-	0/5
/k/	0/10	0/3	0/1	0/14
/g/	4/5	0/8	-	4/13

Table 5 shows a slight tendency for voiced stops to be realized as continuants. Overall, 13 out of 38 voiced stops are realized as continuants (all voiced) whereas only one out of 35 voiceless stops is realized as a continuant. Thus it looks as though there may be the beginning of a voicing distinction, but based on a stop:continuant distinction. The data are too sparse to decide in favour of a single or dual initial system, so this must be explored further.

The fact that there is some indication of a voicing distinction at thi early stage raises the question of how early such a distinction might appear. Recordings have been made since the age of 1;3, so this could be investigated. There are also daily diary records, including transcriptions of words which should be also examined. One indication from the diary that the voicing distinction does appear earlier is shown in a tendency around the age of 1;3 for words beginning with voiceless consonants to have voiceless vowels. This might be interpreted as the voicing distinction being realized in terms of voic onset versus no voice onset. It is thus no longer clear that there is even an early stage without any manifestation of the voicing distinction

Conclusion

This very small pilot study seems to provide some evidence for the first two stages we predicted earlier. Those word-initial stops which can be identified are indeed predominantly short lag, and the measurements indicate no contrast between voiced and voiceless phonemes. On the other hand, there is some evidence for a voicing contrast based on early versus late voicing onset if we pay attention to the large proportion of voiced stops realized as continuants. (More research is needed to determine whether this result holds across all sources.) Further research on acquisition earlier than age 1;7 is needed to determine whether these two stages are in fact sequential, for as pointed out above there is some evidence for the second stage as early as age 1;3. At age 1;7 there is no evidence for the third predicted stage having been reached, this stage being when the voicing systems approach those of the adult language. This, however, will be studied using data after age 1;7. As the two languages separate out, we may expect the early versus late onset contrast to be realized in different ways in the two languages: in English, in terms of short lag versus long lag, and in Spanish in terms of voicing lead versus lag. In Spanish the parameter setting might take longer to become established, because of allophonic and other variations in the linguistic input.

Overall, the evidence so far appears consistent with the hypothesis that universal grammar (=LAD) may contain a voicing parameter which has to be set on exposure to the data from a particular language. The value of a bilingual acquisition study is that, assuming we find a single initial system, it may give us some idea of the nature of the unmarked setting of the parameter. So far our results from the bilingual acquisition of English and Spanish suggest that the unmarke setting of this parameter for stops may be expressed as a contrast between early and late voice onset. The specific details of relative timing and manner of articulation have to be set after longer exposure to the data* and after the two linguistic systems have been separated out.

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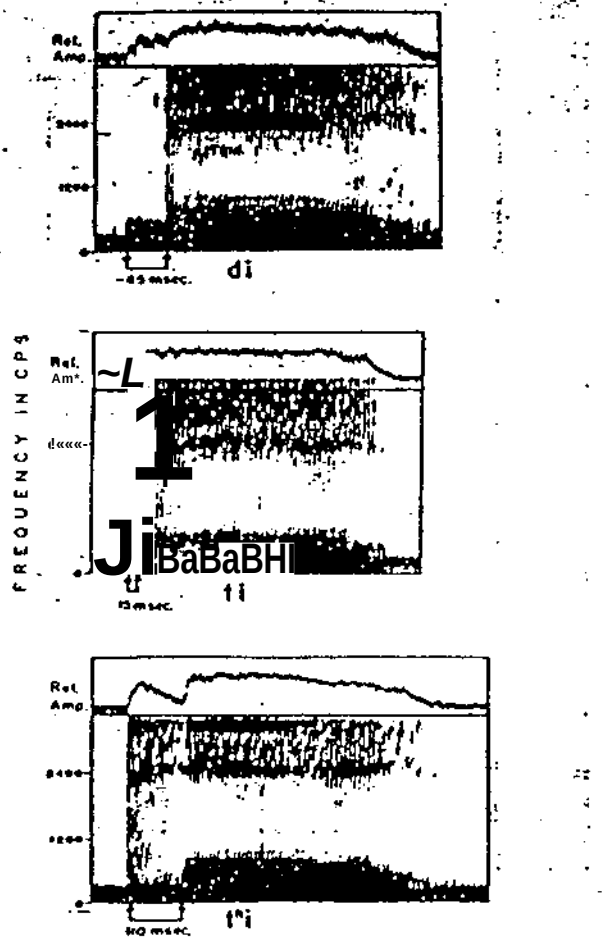
.Figure 1

THREE CONDITIONS OF VOICE ONSET TIME



fFrom Lisker and Abramson (1964:390)