VOICE ONSET TIME IN BILINGUAL GREEK-GERMAN CHILDREN

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ABSTRACT

The independence or interaction between the L1 and L2 phonetic/phonological systems in bilingualism has been a challenging question. This study aims to add to previous literature by investigating voice onset time (VOT) of word initial /p, t, k, b, d, g/ by Greek-German bilingual children. A key factor also examined is the influence of language exposure on VOT variation. Twelve bilingual children living in Germany and attending different schools (Greek and German) and 12 monolingual children for each language were recorded. The results provide evidence of monolingual-like productions and of transfer of voicing features for both voiceless and voiced stops suggesting the presence of two phonetic/phonological systems that interact. Greater exposure to a language in a particular school context can lead to monolingual-like production while less exposure relates to cross-language interference with transfer of voicing features.

Keywords: bilingualism, German, Greek, Voice Onset Time (VOT), language exposure.

1. INTRODUCTION

An intriguing question in research on bilingualism has been whether bilingual speakers possess two independent language systems or an integrated one. At the speech production level, there has been a wealth of studies that attempted to shed light to this debate by examining voice onset time (VOT) in stop production by bilinguals whose languages differ in VOT distinctions, e.g. short lag vs. long lag or voicing lead vs. short lag, such as English-Spanish, German-Spanish, among other pairs. Evidence of monolingual like production of VOT oppositions in the two languages was interpreted to suggest the existence of two independent systems. On the other hand, presence of intermediate "compromise" values indicated the existence of a single integrated system, cf. [1], resulting from phonetic mechanisms such as assimilation or dissimilation [2]. According to the single system hypothesis, bilinguals cannot separate their L1 and L2 phonetic systems fully and therefore some degree of influence between the L1 and L2 will exist.

Thus far, empirical work has provided conflicting evidence as to the above question but most importantly has indicated that variables such as type of bilingualism (simultaneous vs. sequential), language dominance, language mode, context, degree and type of input, extent of L1 and L2 use, and individual variation influence production accuracy by bilingual speakers, e.g. [1, 3, 4, 5, 6].

Research on bilingual children has examined another intriguing question, i.e. whether the phonetic/phonological systems are independent or not from the beginning. Conflicting evidence has been reported on this question too, e.g. [7, 8]. In addition to underscoring the importance of developmental factors in bilingual acquisition [9], evidence suggesting interaction between the systems as manifested in processes such as delay, acceleration or transfer of features has also been reported, e.g. [10, 5].

To date, there are few phonetic studies on bilinguals with Greek as an L1 or L2 and these are limited to adult bilingual speakers. Some of their key findings include the production of longer VOT duration for Greek word initial /p, t, k/ by late Greek-English bilingual speakers compared to monolinguals, as reported in [11]. Beach et al. [12] reported similar VOT duration for English /p/ between Greek-English bilinguals and monolinguals but differences in the realisation of English /b/ which was produced with voicing. Antoniou et al. [1] reported that early Greek-English bilinguals had similar VOT duration to monolingual Greek and English speakers for word initial voiceless stops but some cross-language interference was present for word- medial stops.

The current study examines VOT production in early bilingual Greek-German children. It thus studies an age group and a language pair that has not been investigated before. Greek has a voicing opposition between short lag vs. lead voicing [13] while in German the contrast is between long vs. short lag stops [14]. One of the key factors the current study investigates is the influence of language exposure and use on the voicing contrast as controlled by two different school contexts, i.e. bilingual children attending a German vs. a Greek school in Germany. Previous research has shown that VOT duration of L1 and L2 phones can vary

depending on the degree of exposure to the two languages [15, 6].

The current study addresses the following questions: (i) Is the monolingual Greek vs. German type of voicing contrast maintained in bilingual productions of L1 and L2, i.e. short lag vs. lead in Greek, long lag vs. short lag in German? (ii) is VOT duration in L1 and L2 similar or different to monolingual productions? (iii) is there evidence of interference? (iv) what is the influence of language exposure/use on VOT?

2. METHODOLOGY

The speech material consisted of CVCV real words with word initial / p, t, k, b, d, g/ in the stressed syllable. Target stops preceded /i, ɛ, ɐ, ɔ, u/ in the Greek words and /ɪ, ɛ, a, ɔ, ʊ/[i] in the German ones. They were embedded in the carrier phrase [ˈleɣe __ ˈpali] "say __ again" in Greek and [ich ˈsage __ ˈwieder] "I say __ again" in German. They were repeated 5 times by each subject. In total, 7200 words were recorded and analysed.

Thirty six children were recorded (20 female and 16 male, aged 8;2 to 12;6) these included 12 monolingual Greek, 12 monolingual German and 12 bilingual children of Greek and German. All bilingual children were born and lived in Germany. All were exposed to Greek from birth mainly by their expatriate parents and to German at an early age, i.e. by the age of four. Seven children attended Greek school (21 hours in Greek and 9-11 hours in German) and five attended German school (8 hours in Greek and 20 hours in German).

Data were recorded on a portable Marantz Professional Recorder (PMD661 MKII) with a RØDE NTSS condenser microphone in a quiet room in the schools. Children were shown pictures of the test items on the computer screen and read them aloud in the carrier phrase. For the bilingual children, two separate recordings for Greek and German were conducted on separate days with the presence of a native speaker so as to ensure consistency in language mode.

VOT duration (first burst to the onset of regular pulsing for the following vowel) was measured using PRAAT. A qualitative analysis was also carried out and stops were categorized as fully voiced, partially voiced, voiceless unaspirated, voiceless aspirated. Voiceless stop data were statistically analysed using factorial ANOVA with consonant, vowel, language, and school context as factors. For target voiced stops, productions with voicing lead and lag were found. Therefore, a chi square analysis was performed to examine differences in VOT types (voiced vs. voiceless).

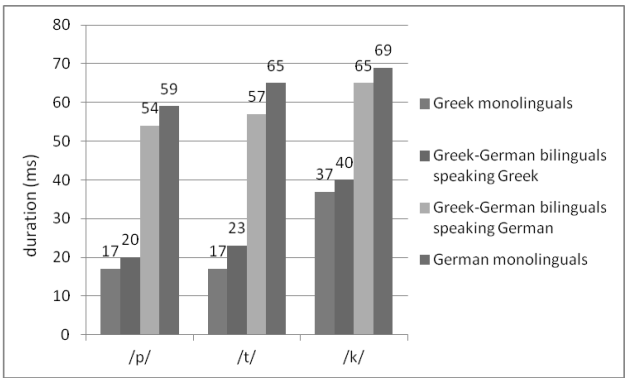
3. RESULTS

3.1. Bilingual vs. monolingual VOT production

3.1.1. Voiceless consonants

Figure 1 shows VOT duration for /p, t, k/ in Greek and German by monolingual and bilingual children.

Figure 1: VOT duration for /p,t, k/ for all groups.



For the monolingual children, short VOT duration for the Greek stops (m=24 ms) and longer for the German (m=64) agrees with previous literature reporting values below 26 ms for Greek and above 50 ms for German [13, 14] mainly from adult data.

For the bilingual children, mean VOT duration was 28ms for Greek and 59 ms for German; this difference was statistically significant ($F(2,1752)=14,43$, $p<0,001$). Moreover, VOT duration by bilingual children in Greek and German was not significantly different from monolingual production (Greek $F(2,1759)=2,65$, $p=0,071$; German $F(2,1773)=1,41$, $p=0,244$).

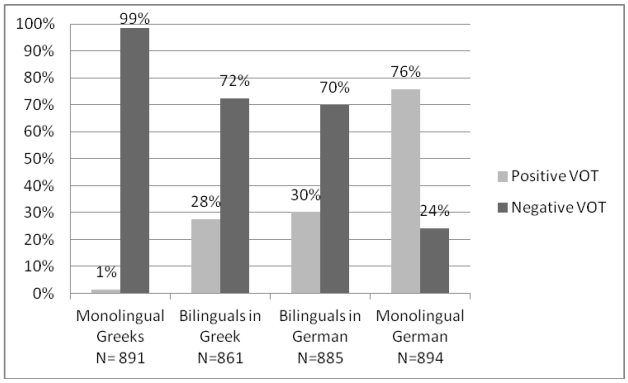
3.1.2. Voiced consonants

Both voiced and voiceless production of target voiced stops was found. VOT duration for /b, d, g/ ranged from -103ms to 21ms for Greek monolingual children, -100ms to 20ms for monolingual German children, -104ms to 33ms for bilingual children in Greek and -107ms to 26ms for bilingual chilren in German.

Percentage voiced vs. voiceless production of target voiced stops is shown in Figure 2. As expected, Greek and German monolinguals followed reverse patterns in target voiced stop consonant production, i.e, more voiced productions for monolingual Greek, and voiceless for monolingual German. [13, 14]. For bilingual children, more

productions with voicing lead are evident in Greek together however with an increase in short lag productions suggesting influence from German. Contrary to what may be expected, more productions with voicing lead are evident in German.

Figure 2: Percentages of voiced stops realized with positive or negative VOT in all groups.



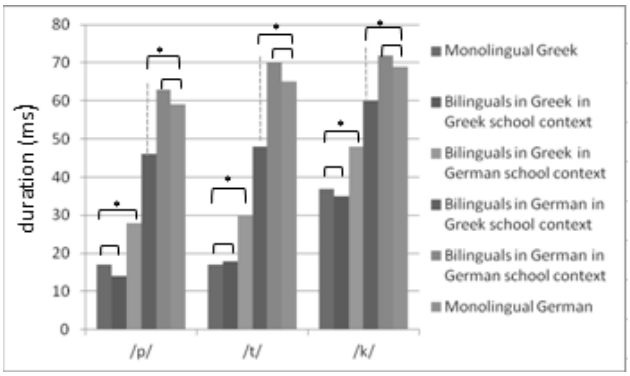
A chi-square analysis was performed to examine differences in VOT types between bilingual and monolingual children (positive vs. negative VOT). Bilingual children in German and Greek had a significantly different ratio of VOT types from the monolingual groups (German: χ^2 (1, N=1778)= 370,61, p<0.001; Greek: χ^2 (1, N=1751)=246,14, p<0.001) suggesting differential realisation of the voicing contrast by bilingual children.

3.2. School context

3.2.1. Voiceless consonants

VOT duration in Greek and German was influenced by the school context (German: F(3, 2654)= 1423,21, p<0,001; Greek: F(3, 2660)= 1259,29, p<0,001). The school context by consonant interaction was also statistically significant (German: F(6, 2660)=17,65, p<0,001; Greek: F(6,2654)=18,26, p<0,001); Tuckey post hoc tests showed that bilingual children with greater exposure to Greek produced /p, t, k/ in Greek with similar VOT duration to monolingual Greek children (p= 0,626 for /p/, p= 0,999 for /t/, p= 0,849 for /k/). In addition, bilingual children with greater exposure to German produced the German stops with similar duration to monolingual German children (p= 0,475 for /p/, p= 0,129 for /t/ and p=0,769 for /k/). Figure 3 shows VOT duration in the different school contexts. Interestingly, children attending the German school had significantly longer VOT in Greek compared to monolingual Greek children (F(1, 1242)=115,85, p<0,001) and children attending the Greek school had significantly shorter VOT in German than monolingual German children (F(1, 1403)=160,69, p<0,001).

Figure 3: VOT duration for voiceless consonants in different school contexts. Asterisks indicate significant differences.



3.2.2. Voiced consonants

Figure 4: Percentages of /b,d,g/ realized with positive or negative VOT by bilinguals in the two school contexts.

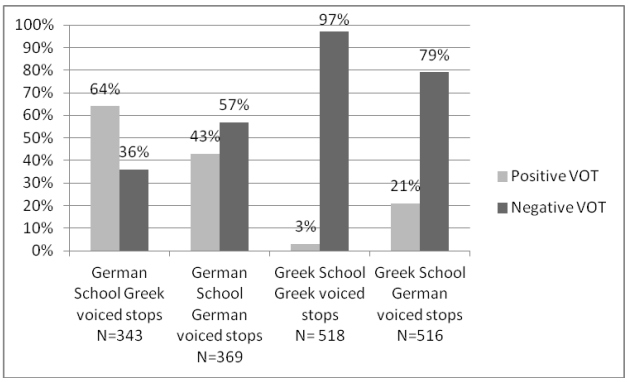


Figure 4 shows the percentage of voiced vs. voiceless productions of /b, d, g/ for the two languages in the two school contexts. More voiced productions are evident both in Greek and German in the Greek school context. Interestingly, in the German school more voiceless stops are produced in Greek and more voiced in German. The chi-square analysis showed that in Greek the VOT type ratio of the bilinguals who attended a Greek school was similar to that of monolingual Greek children for /b/ and /d/ (/b/: χ^2(1, N=470)=0,53, p=.47, /d/: χ^2(1, N=466)=2.33, p=.13) but not for /g/ (χ^2(1, N= 470)=9.06, p<.003). Bilinguals who attended a German school had a significantly different VOT type ratio to that of monolingual Greek children for all consonants (χ^2(1, N=1233)=639.670, p<.001). In addition, in German, bilinguals in the German school and bilinguals in the Greek school had a significantly different VOT type ratio for all consonants compared to monolingual German

children (German school: $\chi^2(1, N=1263)=122,41$, $p<.001$, Greek school: $\chi^2(1, N=1410)=400.77$, $p<.001$), (see figures 2 and 4).

4. DISCUSSION

Overall, results on voiceless stop production in Greek and German indicated that bilingual children matched monolingual VOT production, i.e. they produced short lag stops in Greek and long lag stops in German. While this was a global finding when all children were pooled together, interesting variation was observed in the analysis of the school context. Bilingual children attending the Greek school produced the Greek voiceless stops with similar VOT duration to monolingual Greek children. In addition, children attending the German school produced the German stops with monolingual-like VOT duration. However, bilingual children attending the Greek school produced German stops with shorter VOT while children attending the German school produced the Greek stops with longer VOT.

This clearly suggests cross-language influence in production. If the school context is an indicator of greater language exposure and use, and possibly language dominance, then it is clear that VOT duration in the dominant language matches monolingual VOT production while there is cross-language interference when the bilingual child speaks the less dominant language, cf. [5]. An interesting tendency that was also observed was that bilinguals with more exposure to Greek generally produced Greek voiceless stops with shorter VOT duration than monolingual Greeks stops (with the exception of /t/). Similarly, bilinguals with more exposure to German produced all German voiceless stops with longer VOT values than monolingual Germans. Although not statistically different, this pattern may be interpreted to point towards a tendency bilingual children may have to keep the two phonetic systems distinct by increasing target distance. Bilinguals with less exposure to either Greek or German produce intermediate VOT values which are significantly different to those of monolinguals indicating cross-language transfer of voicing features. Similar results for voiceless stops have been reported for other language pairs, e.g. longer VOT duration in Japanese and French voiceless stops by English-Japanese and French–English bilinguals [16, 17, 18].

With reference to voiced stop production, a clear difference in the implementation of the voicing contrast was evident in the Greek vs. German monolingual children. As expected, a majority of productions with voicing lead in Greek and with short lag in German was found. While bilingual children in Greek also showed a predominance of lead productions (72%), there was a considerable increase in short lag VOTs (from 1% in monolinguals to 28% in bilinguals) indicating an influence from German, cf. [19]. Unexpectedly, more lead productions were found in German for the bilingual children. When these results were broken down into the two school contexts, interesting variation was observed. More productions with voicing lead in both Greek and German were evident in the Greek school context. While this is expected in Greek, presence of more pre-voiced productions in German indicates influence from Greek. Similar results have been reported for English voiced stops, i.e. higher amount of voiced stops produced with voicing lead, for English-Spanish, Panjabi-English and Greek-English bilingual speakers [20, 21, 12] indicating cross-language transfer of voicing features. Moreover, influence from German is also evident for Greek /b, d, g/ in the German school with the majority being produced with short lag VOT (64%). As mentioned above an unexpected finding was that German voiced stops in the German school showed a majority of voicing lead productions (57%) with short lag ones at 43%. Interestingly, the qualitative analysis of the voiced stops showed the frequent presence of tokens with both pre-voicing and a short-lag interval after release, cf. [22]. Precedence of the lag vs. lead time in perception has been shown in previous research and may account for the pattern observed [23].

In conclusion, evidence of monolingual like productions and of transfer of voicing features for both voiceless and voiced stops suggests the presence of two systems that clearly interact, cf. [1, 5]. A key factor that conditions the variation observed in this study is language exposure and use as related to the different school contexts. The differential amount of exposure to Greek and German in the two contexts may relate to language dominance effects [15, 16]. Overall, our results show that greater exposure to a language leads to monolingual-like production and less exposure to cross-language interference as evident by the transfer of voicing features.

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[i] Except for one word where the stop was followed by a long back /u/.