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Interaction between bilinguals'first languages: An exploratory study in a group of Greek-German early bilinguals and Greek heritage speakers.

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Abstract

In alignment with the previous research attempts to determine the interaction between the first languages of bilinguals (Fabiano-Smith & Goldstein 2005; Fabiano-Smith & Goldstein 2010; Goldstein & Bunta 2011), the present study examines the influence of German as the dominant language on Greek phonology in the Greek-German bilinguals. The results collected are built on the accuracy scores as well as on the patterns used by 3 Early Greek-German bilinguals and 3 Greek Heritage speakers (aged 7-8) living in Germany. The phonemes under investigation were the [x]-[ç] allophones that are present in both Greek and German phonology but appear in different environments and the [zm] consonant sequence that is common in Greek but absent in the German language. The results revealed a German to Greek phonological influence in the form of transfer in both parts of the experiment as well as a deceleration compared to their monolinguals peers (Genesee & Paradis, 1996).These findings are discussed in the light of Speech Learning Model (Flege, 1995; 2007) and of the Interdependence Hypothesis (Genesee & Paradis, 1996) as well as on the findings of Barlow's (2014) paper.

Keywords: Interaction, bilingualism, phonology, acquisition, allophony, transfer, decceleration

1. ## INTRODUCTION

A series of case studies in the past have explored the interaction between the bilinguals' two languages. (Barlow; 2014; Barlow, Branson & Nip 2013; Fabiano-Smith & Goldstein, 2010; Genesee & Paradis, 1996). Previous studies that have been conducted explored the syntactic, pragmatic and lexical bidirectional influence between the two languages of the bilinguals. The researchers nowadays attempt to predict the type of interaction that may occur between the two languages as well as provide the roots that underlie this specific phenomenon. Interaction according to the previous findings can

occur due to both intrinsic and extrinsic factors. The age of acquisition of the two languages, the age of the speakers, the amount of exposure each learner received in both languages and the language dominance belong to the intrinsic factors category (Flege, 1991; Flege, Muntro & Kay 1995; Flege, Yeni-Komshian & Liu 1999; Flege 2002; Fowler, Sramko, Ostry, Rowland & Halle 2008; Simonet, 2010; Antoniou, Best, Tyler & Kroos 2011; Lee and Iverson, 2012.) Extrinsic factors are related to linguistic features like frequency, markedness and similarity (Lleó, Kuchenbrandt , Kehoe & Trujillo 2003; Broselow, 2004; Fabiano-Smith and Goldstein, 2010). The present thesis focuses on 'similarity' in a study of Greek-German bilingual children. More specifically, the focus lies on two phonological processes of the Greek language, one of which has a very similar counterpart in German. The first process relates to similar allophones in both languages, the [x]-[ç] allophones, which however appear in contrasting phonological contexts in each language. The second phonological process is a voicing assimilation rule between a fricative and a following nasal, which is present in the minority language of the participants (Greek) while in the majority language (German) it is absent. The main goal of the study is to explore the type of interaction between these processes in Greek-German bilingual children, and more specifically in which way their Greek phonology will be affected by their knowledge of German phonology.

According to previous studies carried out in this field a feature that is similar or shared in both languages is more likely to yield interaction between the two languages rather than a feature that exists in only one language or is completely dissimilar (e.g., Flege, 1995, 2007; Flege et al., 1999, Flege, Schirru & MacKay 2003; MacWhinney, 2004; Fabiano-Smith & Goldstein; 2010). More specifically, Flege (1995) and his research team developed the Speech Learning Model that was referring to the model of second language acquisition. The main target of this model was to search for the underlying factors and the reasons why second language learners achieved or failed to learn and accurately produce specific phonetic segments of their second language (Flege, 2005). Fabiano-Smith and Goldstein (2010) later adapted this theory model to bilingual acquisition claiming that it is more probable for the bilinguals' first languages to interact when they share a common feature. In their paper, Keffala, Barlow and Rose (2016), although they highlight the importance of all these studies that have taken place exploring

the similarity feature, denote the need for further studies that would deal with features that are not common in both first languages. Such cases could contribute to the current literature on bilingual acquisition as well as help us understand the cross-linguist interaction and its roots.

As previously mentioned, similarity indeed cultivates the interaction between the bilinguals two languages. The question that the researchers had to answer is what kind of interaction will eventually take place. In their attempt to determine the form of interaction that takes place between the languages of the bilinguals, Genessee and Paradis (1996) proposed the Interdependence Hypothesis. More specifically, according to their studies there are three concepts that may emerge in the bilingual process of acquisition. The first hypothesis is that the acquisition of one of the two languages may be delayed due to the later or simultaneous acquisition of the other language. This phenomenon is named 'deceleration', in other words, while bilinguals start learning a language they may acquire some features at a slower rate than their monolingual peers. More recent research has indicated instances of deceleration in syntactic acquisition but also in phonological acquisition (Fabiano-Smith & Goldstein, 2010; Giedersleeve, Davis & Stubbe, 1996). The second hypothesis of the Genesee and Paradis (1996) paper is that the simultaneous acquisition of two languages might accelerate the rate of learning of the children compared to their monolingual peers. More specifically, the bilinguals may employ one of the languages in order to assist the acquisition of the other one which can result into a faster rate of acquisition of these particular features than the monolinguals. Further studies on this concept of acceleration have documented such instances (Tracy, 1995; Gawlitzek- Maiwald & Tracy 1996; Kehoe, Trujillo & Lleo, 2001). For instance, compared to their Spanish monolingual peers the German-Spanish bilinguals acquired the coda consonants faster (Kehoe & Trujillo, 2003). The third hypothesis presented in the paper is that several features of both languages may be transferred from one language to the other. In the light of these two theories for this thesis a small scale study was conducted aiming to explore the phonological interaction in a group of Greek-German bilinguals, more specifically the influence of German phonology on the Greek one. In the present study the transfer and the deceleration hypotheses will be examined. The question

that is explored is how similar and dissimilar phenomena affect the phonological acquisition of a particular bilingual group.

Deceleration

Out of the three types of interaction, the present study will deal with two of them. The first one is deceleration. Deceleration is the result of the cross-linguistic interaction between the bilinguals' first languages. When the acquisition of one language has a negative effect on the acquisition of the other language this is the phenomenon of deceleration. The reason of the delay lies in the fact that bilingual acquisition is more demanding than monolingual acquisition. Bilinguals, compared to their monolingual peers, have to face two challenges when acquiring two phonologies and forming phonological categories. First, compared to their monolingual peers they receive less input in each of the languages (Kohnert 2008; Kohnert, Yim, Nett; Kan & Duran, 2005). The second challenge the bilinguals have to face is the variability in the input received due to differences in structure between the two languages (Werker & Curtin, 2005). A series of studies have been launched in order to investigate the cross-linguistic interaction between the two languages in the form of delay. Kehoe (2002) chose the population of Spanish-German bilinguals in order to explore vowel acquisition. She hypothesized that the differences in the phonologies of these two languages and more precisely in vowel length (German has a more complex vowel inventory than Spanish) could provoke a delay in the acquisition of more difficult features in the bilinguals. Like Kehoe (2002), Lleo and Cortes (2013) also noticed a delay in the acquisition of long vowels by German-Spanish bilinguals. Fabiano and Goldstein (2010) explored consonant acquisition in the Spanish-English bilinguals. Their results provided evidence for Flege's hypothesis (1987) that the bilinguals tend to categorize the similar sounds in a phonemic category that is common for both languages. As mentioned in Keffala, Barlow and Rose (2016), these results highlight the importance of frequency of occurrence of a feature in the language in the type of language interaction that occurs. In the paper by Gildersleeve-Neumann Kester, Davis, and Pena (2008), Spanish-English bilinguals again exhibited traces of delay in bilinguals' interdental /s/ and affricate productions. The authors concluded that the amount of exposure the bilinguals receive determines the success rates in the

acquisition of certain features. An investigation of a language pair that has not been studied till now, Greek-German, and of a feature that is either absent in one of the languages, or occurs in a contrasting context, will enable us to understand better how bilinguals acquire the phonological systems and the potential causes of delay.

Transfer

Bilingual children especially at an early age tend to transfer some sounds or sound patterns from one language to the other. There are several types of transfer. According to Paradis and Genesee (1996) the transfer from one language to the other and vice versa constitutes a proof for the between-languages interaction whereas a low-level of transfer between the two languages points to a low-level interaction (Schnitzer & Krasinski, 1996). Furthermore, according to later studies on transfer that followed (Keshavarz & Ingram, 2002) transfer constitutes evidence for overlap of the two language systems. As Bunta and Goldstein (2011) suggest there are two types of transfer, positive and negative. When positive transfer emerges this means that bilinguals develop their phonological skills faster or at the same pace with their monolingual peers due to multiple cues that they receive in both of their first languages. For instance, in the study of Gawalitzek et. al (1996) an English-German bilingual acquired the infinitival phrase structure faster than the average rate of monolinguals since it is a common feature in both English and German. Later on, in the study by Arnold, Curran, Miccio and Hammer (2004) their monolingual and bilingual participants exhibited similar levels of accuracy in the pronunciation of consonants. However, the results vary across studies of the transfer phenomenon. In their research, Dodd, So and Li (1996) found instances of negative transfer across the phonological systems of Cantonese-English bilingual participants who seem to face a delay in the mastering of phonological skills of their languages compared with their monolingual peers. Similar results were presented in the study of Gildersleeve-Neumann Kester, Davis, and Pena (2008) who noticed a generally lower accuracy score in consonant and vowel productions of English-Spanish bilinguals in their English pronunciation. The fact that several studies with the focal point on the phonological acquisition of the bilinguals resulted in different conclusions was the launching force to deal with and investigate more this topic. According to Barlow (2014) the main questions

that arise from these findings concern the way these types of transfer will appear in bilinguals' speech as well as the conditions under which the transfer will emerge.

The core body of research focusing on bilingual cases has dealt with the biggest bilingual group in the United States, namely the English-Spanish bilinguals. (Fabiano-Smith & Goldstein, 2009; 2010; Gildersleeve-Neumann et. al, 2008). The present study focuses on a bilingual group that has not been investigated thoroughly yet, the bilingual Greek-German minority in Germany, and studies the acquisition of allophony. This topic has been explored in the English-Spanish population (Zampini, 1994; Eckman and Iverson, 1997; Barlow et. al 2011; Barlow, 2014;). However, studies on bilinguals with language combinations that are generally understudied are highly recommended by researchers since they can complete the overall picture of bilingual cross-linguistic interaction (Fabiano-Smith & Goldstein, 2010).

Current study

The present study is inspired by Barlow's study (2014). Barlow's paper focuses on the age of acquisition of allophony in English-Spanish bilinguals. In her study Barlow (2014) explores the phonetic differences in the /l/ productions of English-Spanish bilinguals based on language similarities and on the participants' knowledge of the phonological rules of each language. In alignment with the Speech Learning Model (SLM) as proposed by Flege (1995; 2007), which postulates that a common phonological feature in both languages of a bilingual would cause a bidirectional interaction, the bilingual participants indeed exhibited interaction patterns in their /l/ productions. However, there was a difference between Early and Late Bilinguals. More precisely, the English /l/ productions of the Early Bilinguals seem to be only slightly affected by the Spanish language since their /l/ productions' were clearer. In the case of the Late Bilinguals, however, the participants not only exhibited a greater influence of the Spanish language on the English one but they indicated a greater phonological influence from English to Spanish since the English allophonic rule was employed in Spanish.

In the current study the focus is placed on the influence of the German language that is the dominant language of the heritage speakers and the early bilinguals studied

here, on the Greek language, which is the minority language. The features that are under investigation are of particular interest. Participants are requested to read out words involving the [ç]-[x] allophones. Both of these allophones are present in the phonologies of German and Greek language and are also similar in their pronunciation. However, they do follow contrasting rules as far as their implementation in the two languages is concerned. Compared to the Greek phonological rule postulating that [ç] is produced *before* the [i] and [e] front vowels and [x] is produced before back vowels, in German the context of these two allophones is the reverse, as [ç] appears *after* the above mentioned front vowels (Wiesel, 2000, Hall 1989), and [x] is produced after back vowels. In both languages these allophones are in complementary distribution, meaning that the occurrence of one automatically excludes the emergence of the other. In (1a) and (1b) below are examples from Greek and German respectively.

1)   a) χήνα [çina] 'goose', χέρι [çeri] 'hand', χορός [xoros] 'dance'

        b) sicher [ziçer] 'sure' frech [fʁɛç] 'rude' lachen [laxən] ' laugh'

The second feature under investigation is the underlying [sm] consonant sequence and more particularly the voicing assimilation rule that influences this sequence. According to phonotactic restrictions of Greek, the feature [+voice] spreads from a voiced consonants /γ, β ,μ / to the preceding /s/, even across word or syllable boundaries. In (2a) and (2b) are examples of this assimilation process from Greek that occur within the words and in sentences respectively.

3)   a) χάσμα [xa**zm**a] ' gap' , πείσμα [pi**zm**a] 'stubborness'

        b) Ο μπαμπάς γυρίζει [o baba**z g**yrizei] 'The dad returns', ο φίλος **μ**ου [o filo**z m**u] 'a friend (of) mine'

This phenomenon is frequent in Greek. In previous studies (Pelekanou & Arvaniti, 2000; Tsardanelis, 2005; Baltazani, 2007) all researchers documented the voicing assimilation that occurs when /s/ precedes a voiced consonant, despite the slight differentiations in the levels of the voicing reported. In German, however, this particular sequence is absent. As Grijzenhout & Joppen (1998) mention in their paper, [ʃ] and [s]

are the only fricatives that can occur before the [m] e.g. Smied [ʃmiːt] and Smaragd [ʃmarakt]. As it can be noticed there is no trace of voicing assimilation occurring in this particular cluster. What is more, in a word-internal position, this cluster seems to be syllabified as coda-onset sequence. Thus the words like *Charisma* and *Kosmos* are pronounced as [karis.ma] and [kɔs.mɔs] respectively.

The novel contribution of the present study compared to Barlow's paper (2014) can be summarized in the following points. To begin with, the group under investigation, Greek-German bilinguals being raised in Germany, has been barely studied before and bilingual data from this constantly growing population are limited. Thus, in order to enhance the literature regarding bilingual phonological acquisition but also to provide an overview of this particular bilingual population, it is worthwhile to conduct a small-scale experiment that provides data for further studies. In addition, the participants' age in the present study ranges from 7-8 years old. Previous studies either dealt with adults who have a stabilized phonological inventory (Barlow, 2014) or really young bilinguals whose phonological skills are still being developed (Sebastian-Bosch & Galles, 2003; 2007;2009) The heritage learners started visiting German kindergarten at 4-5 years, and at 7-8 years have thus received 3-4 years of input in their second language. It is of great interest to have an insight in this transition stage, where the child changes from being monolingual to being bilingual, and to trace potential changes in their phonological skills. Besides, Barlow explores the transfer from the dominant language to the participants' heritage language using an allophone that emerges in the dominant language. In the present study the segments under investigation, [x]-[ç] are existing segments in both languages, but the allophony [x]- [ç] follows competing rules, while the sequence [zm] does not exist in the child's second- and dominant-language, German.

The participants of this study, children with a mean age of 7.5 years, are divided in three small groups. The first group (N=3) consists of early bilinguals since they are exposed to both languages from birth. The second group (N=3) consists of heritage learners since the main feature of this group complies with the definition (Valdes, 2005; Mortrul, 2016) postulating that the heritage language is the non-societal and non-majority language which is mainly used in the family environment. A minority language is

preserved because of the conscious and determined attempts of the parents who want their children to be able to comprehend and use this language. The language is used only in this specific environment whereas their formal education is conducted in the majority language, in this case the German language (Valdes, 2005). This group is not labeled as "second language learners" in the study of Valdes, since this name would emphasize the second language acquisition aspect, which is not the main characteristic of this group. The groups of the Greek children raised in Greek speaking families in Germany comply with the specifications of heritage learners, since until the age of 4, the time they started receiving proper instruction in the German language, they are predominantly exposed to the family language (minority language). The final group consists of monolingual Greek speakers (N=3).

The purpose of this study is to determine the way in which the interaction between the dominant and the minority language affects the phonological systems of the Greek-German bilingual group.

The expectations for the two types of segments differed since the children had to deal with two different features of the Greek phonology which were also different from the German phonology. As an overall estimation and based on Flege's Speech Learning Model (SLM) (1995) as well as on Fabiano-Smith and Goldstein's research (2010) claiming that bilingualism yields the interaction between the bilinguals' two languages, it is predicted that both groups will make pronunciation errors when producing the Greek words resulting from the interaction with the German phonology. However, in alignment with Barlow's results it is expected that the productions of the Greek-German Early bilinguals will differ from those of the Greek Heritage Speakers. To be more specific, the Greek Heritage speakers, taking into consideration the amount of input and exposure they have received in the Greek language, are expected to exhibit higher accuracy scores compared to their early bilingual peers. More specifically, they are expected to apply the Greek phonological rules more frequently whereas the early bilinguals are expected to exhibit only a limited implementation of the above mentioned rules that agrees with their limited exposure to the Greek language.

As far as the [x]-[ç] allophones are concerned it is worth mentioning again that these are on the one hand present in both phonologies, but however, follow competing rules in their implementation. As explained previously, in the Greek language [ç] precedes the front vowels [i] and [e] whereas in German it follows these vowels. Thus, although these allophones do comply with the Speech Learning Model since they are similar in both languages, the fact that they follow competing rules in each language complicates their acquisition for bilinguals and therefore it can result in a delay in the acquisition of the phonological rules compared to their monolingual peers. Taking each group separately it is expected that the Heritage Speakers will employ the [ç]-[x] phonemes in the correct language environment more frequently than the early bilinguals. Based on the results of Barlow (2014) according to which the Spanish-English bilinguals did transfer the English /l/ to their heritage language (Spanish), a similar trend of transfer could be expected in the German-English bilinguals. However, the fact that that these two allophones [x] and [ç] occur in competing contexts in each language, may eventually result into confusion of the participants. As a result it is predicted that the participants of both groups will not follow a particular pattern when dealing with these allophones.

As far as the second part of the experiment is concerned, the Greek heritage speakers are expected again to provide more accurate productions than the early bilinguals group. Since this voicing assimilation rule is absent in the German language it will be intriguing to investigate the way the participants deal with this feature. In contrast to the previous studies (Barlow 2014; Barlow et al., 2013;) where the phonological feature explored appeared in both languages, in this part of the research the [zm] consonant sequence and the voicing assimilation rule that underlies it are present only in the minority language of the participants. It is therefore expected, taking into consideration the relative dominance of German phonology over the Greek one that the participants will attempt to eliminate the voicing assimilation in their minority language too. Instead they are expected to assimilate the Greek [zm] sequence to the German phonology by either splitting the cluster when in mediate position i.e *kosmos* [kɔs.mɔs]. or to produce [ʃm] since this conforms to German i.e. *Schmeterling* [ʃmeterliɲ] , *Geschmack* [Geʃmak]. In this way, the hypothesis that unshared sounds between two

languages hinders the acquisition of both languages would be validated (Flege, 1995; Goldstein, Fabiano & Inglesias, 2003; Goldstein & Fabiano, 2010).

2. <u>**MATERIALS AND METHODS**</u>

Participants

Nine children took part in the study. These included 3 Greek monolinguals (2 female, 1 male) with a mean age of 7;6 years, 3 Greek-German bilinguals raised in Germany by one Greek and one German parent with a mean age of 7;8 years ranging from 7;8–7;9. (2 female, 1 male) and 3 Greek-German heritage speakers of Greek (2 female, 1 male) with the a mean age of 7;8 ranging from 7;2-7;8. I decided to take a sample of children of this age group since they have developed a more solid phonological system and they could read. All participants were children with typical language development without any hearing or cognitive problems. In order to elicit information regarding the children's linguistic abilities and skills one of the caregivers was requested to complete a questionnaire (adapted from Mortul, 2012) concerning their own and their child's linguistic skills (input and output) in both languages. Among other questions s/he was requested to provide an estimation of the usage of both Greek and German in the family's daily life including also the child's activities in and outside the family environment. They answered specific questions about the age of acquisition of the German language, the amount of hours their children and themselves used each language as well as the context in which they chose to use each language. The caregivers also had to rate their own and their child's productive and receptive skills in both languages. It is important to have a linguistic overview of the caregivers since for the first years of the child's life they are the main source of exposure to a language. The children with two Greek parents are heritage speakers and are labeled as HSp, whereas the children who have one German parent and one Greek parent and were exposed to both languages from birth are labeled B and are Early Bilinguals. This categorization was made following the criteria provided in Mortul's (2016) work about the heritage speakers theory and the previous study cases on Early bilinguals (Scovel, 2000; Barlow, 2014). The Greek

heritage speakers' exposure to the German language started in the kindergarten from the age of 4 (Mortrul, 2016). The early Greek-German bilinguals were exposed to two languages from birth and this leads to native acquisition of both languages exposed to. The input and output percentages were calculated following the model of Genesee, Paradis and Cargo (2004), more specifically, by multiplying the number of hours of exposure (input) or use (output) by 100 and then dividing the number by the total number of hours in the week. However, in order to reach the percentages of actual language use I subtracted the average hours of sleep (8) per day for each day of the week.

A child who receives a minimum of 20 percent of exposure and use in the Target Language is considered Bilingual (Fabiano-Smith & Goldstein, 2010). All the participants surpass this percentage, a fact that makes them suitable bilingual participants. As expected the children with caregivers of Greek origin do have higher percentages in both exposure and usage. Their Greek input reaches almost 40 percent whereas the output is a bit lower, at approximately 30 percent. In the questionnaire provided, the parents were also asked to rate on a scale from 1 to 5 their child's linguistic ability in both languages. The parents of the early bilingual children considered the linguistic ability of their children in Greek language a bit lower compared to their performance in German. On the other hand, the parents of the heritage speakers presented a more balanced linguistic portrayal of their children's competence in both languages.

The higher upper age limit for acquisition of phonology is around the age of 5 (Flege et al, 1999; Scovel 2000; Newpot et. al 2001) and since the previous studies dealt mostly with bilingual infants (Albareda-Castellot, Pons, Sebastian-Bosch & Galles, 2011;Sebastian-Bosch & Galles, 2003;2009) and early learners around this age (Gildersleeve-Neumann & Wright, 2010) I decided to focus on bilinguals in a slightly older age group, since by then they are supposed to have a more solid knowledge of the phonological systems of both languages. Besides, according to Papadopoulou (2000) the age of acquisition of /x/ for Greek monolingual children ranges from 3;7- 4;0 years old whereas the /ç/ allophone is acquired between the ages of 4;1 and 4;6, at the same age Greek children also start producing also the [zm] sound. Thus, taking into consideration that especially for the [zm] sound there could be a possible delay in the acquisition I

decided to take a sample of children of an age range from 7;2 to 7;9 years old, to ensure that they would have a developed a more stable phonological system. In addition, since the stimuli were presented to them in written form, they needed to be able to read.

Child ID	Age	Gender	Mother's education	Percentage of Greek input	Percentage of Greek output	Percentage of German input	Percentage of German output	Proficiency in Greek (Scale 1-5)	Proficiency in German (Scale 1-5)
B2101	7;9	M	Phd	35	33	65	67	3	3
B102	7;2	M	University	27	27	73	73	2	3
B2103	7;8	F	Phd	39	33	61	67	3	3
B104	7;5	M	University	22	20	78	80	2	3
B105	7;8	F	University	28	26	72	74	3	3
B2106	7;7	F	University	38	32	62	68	2	3

Table 1. Overview of the participants Greek – German language use.

Stimuli and recording procedures

In order to evaluate the participants' [x]-[ç] productions, a list of 60 written items in Greek was created. Thirty-two were non-words in the form of CVC, VCV, CVCV, and the other thirty-two were common Greek words (*Tables 2 & 3*). In each set, sixteen words included the phonemes under investigation whereas the rest were fillers. The sounds leading to the [x]-[ç] allophones were presented in sequences either following or preceding the vowels /i/ and /e/. In order to test how the bilinguals would deal with underlying /sm/ sequences, a list including 20 items (*Table 4*) was composed. Half of them involved the underlying cluster /sm/ cluster and the rest were filler words. At a later stage, 3 extra /sm/ items as well as 2 extra filler words were added because of low performance of the children on the original list of words. The full list entailing the stimuli used for each task is provided below. The participants were interviewed alone in a quiet room in their house in order for them to feel more comfortable. All their productions

were digitally recorded with a microphone through Praat software. The participants were asked to read aloud the words and the non-words from the two lists. The stimuli were written on small cards which were presented to the participants one after the other in a random order, so that they could not expect the word that would appear next. As soon as they provided their production the next card would be presented. They held the microphone with both hands and kept it at a distance of aproximately 15 centimeters from their mouths. In this way potential sound distortions were avoided. Their productions were filed directly on the computer in order to be phonetically transcribed later.

Stimuli			
Non-words /ç/	**Target productions**	**Words /ç/**	**Target productions**
όχι	[oçi]	αχινός	[açinos]
χάχι	[xaçi]	βροχή	[vroçi]
χίχ	[çix]	απόχη	[apoçi]
άχι	[açi]	χέρι	[çeri]
μπάχι	[baçi]	ταχύς	[taçis]
πέχ	[pex]	μάχη	[maçi]
χίχα	[çixa]	κοχύλι	[koçili]
χέχ	[çex]		
ποχί	[poçi]		

Table 2. [ç] stimuli

Stimuli					Stimuli	
Non-words /x/	Target productions	Words /x/	Target Productions		Words	Target productions
χάχι	[xaçi]	στίχος	[stixos]		άσμα	[azma]
λίχ	[lix]	έχω	[exo]		σμαράγδι	[zmaragdi]
χίχ	[çix]	ήχος	[ixos]		σμήνος	[zminos]
ίχα	[ixa]	Τοίχος	[Rixardos]		κόσμος	[kozmos]
πέχ	[pex]	Ριχάρδος	[mixani]		ύφασμα	[ifazma]
χίχα	[çixa]	μηχανή	[vixas]		μούσμουλο	[mouzmoulo]
χέχ	[çex]	βήχας	[ixo]		αγκάλιασμα	[agkaliazma]
πίχο	[pixo]	ηχώ			φάντασμα	[fantazma]
κίχ	[kix]				κάθισμα	[kathizma]
έχα	[exa]				Σμαρώ	[zmaro]
λέχ	[lex]				[ασβός]	[azvos]
ίχο	[ixo]				[σγουρός]	[zgouros]
					[σβούρα]	[zvoura]

Table 3. [x] stimuli   *Table 4. [zm] stimuli*

Analyses

Each word production was extracted from the original recording and was analyzed acoustically in Praat (Barlow et. al, 2013 ; Boersman & Weenick, 2008). Each production of the sounds of interest was acoustically and visually identified using spectograms and was phonetically transcribed. All the transcribed productions from heritage and early bilinguals were compared to each other but also to those of the Greek monolinguals, that were used as model productions. Overall accuracy percentages of each task were calculated for each group in order to determine if bilinguals and heritage speakers were demonstrating evidence of acceleration or deceleration compared to their monolingual peers. In order to determine whether the participants' productions did comprise instances of phonological transfer, the substitution error analysis adopted by

Fabiano-Smith and Goldstein (2010) was utilized. Given that the focus of the study is on the transfer phenomenon, if the participants used a language-specific or unshared sound of German in the productions of the Greek words (e.g. the German /ʃ/ instead of Greek [z] in the underlying /sm/ cluster) it was counted as a transfer. Instances of transfer were also examined for overall patterns that the children were utilizing (i.e. whether they showed preference for certain German sounds as substitutes) and (b) the language-specific sounds used as substitutes. Interestingly enough, certain strategies deriving from the participants' attempt to balance the use of each language were also found in the recordings in both bilingual groups and have been transcribed.

3. **RESULTS**

The results of the fricative and the clusters' tasks will be presented separately in the following section. The target [ç] productions per participant were in total 15, 7 for words and 8 for non-words. The number of target productions for [x] were 8 and 10 respectively, per participant. The total number of target productions for [ç] words and non-words were 90 and for [x] 108. In the task of the [zm] productions the target productions recorded were 10 per participant which makes a total number of 60 productions. An equal number of productions in every task was documented also for the Greek monolinguals. Three words that should result in the voicing assimilation sequences [zg] and [zv] were later added to the initial set in an attempt to crosscheck the initial really low results of the participants concerning the voicing assimilation rule. This resulted in a total number of 69 productions.

In *Table 5* are presented the results of the first task of the research concerning the [ç]-[x] allophones. As can be deduced from the table below, the heritage speakers have a higher overall score than the early bilinguals in both non-words and real words. More specifically, heritage speakers obtained 37 accurate non-word productions out of 48 whereas the early bilinguals have a slightly lower number since they have 32 accurate non-word productions. Similar results are illustrated in production of the real words. At this task 48 out of the 54 words including the [ç]-[x]allophones were correct in the

heritage speakers' group compared to 44 out of 54 correct productions of the early bilinguals' group. The productions of each participant will be shown and discussed in further detail in the following part.

Testing the [ç]-[x] allophones					
Heritage Speakers			**Early Bilinguals**		
Ch1	**Ch3**	**Ch6**	**Ch2**	**Ch4**	**Ch5**
Non-Words					
13/16 **81%**	10/16 **62,5%**	13/16 **87,5%**	7/16 **43,8%**	12/16 **75%**	11/16 **69%**
TOTAL: 37/48 (77,7%)			30/48 (62,5%)		
Words					
18/18 **100%**	17/18 **95%**	13/18 **75%**	14/18 **77,7%**	15/18 **81%**	15/18 **81%**
TOTAL: 48/54 (88,8%)			44/54 (81,4%)		

Table 5: The accuracy percentages of both groups for the [ç]-[x] task.

Heritage speakers vs Early bilinguals

Compared to the monolinguals' data, which were 100% accurate, the scores of the other two groups were lower. In *Figure 4* the accuracy scores of each group are depicted. As illustrated, for both groups the percentages of correct productions for the [ç]-[x] non-words are lower than those of the real word productions. However, in both tasks the Hsp group surpasses the performance of the EB group. The results for each participant in each group are presented and analyzed below.
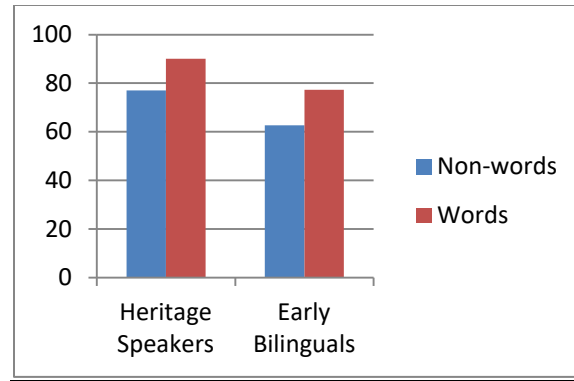
*Figure 1: Mean Accuracy Percentages for Heritage Speakers and Early Bilinguals*

Greek monolinguals

In order to have a model for the correct Greek productions, the answers of three Greek monolinguals were collected and documented. The Greek monolinguals were of the same age as the bilingual participants. None of the monolingual participants faced any problem with the features under investigation. And all of them had a 100% accuracy percentage in both tasks.

Bilinguals vs Monolinguals

As mentioned above the monolinguals' productions were used as controls for the productions of the bilingual groups. On the whole, the Heritage Speakers are closer to the monolinguals than to the early bilinguals in their production accuracy. In the following figures the differences between the three groups in each task are illustrated. The non-word presented in *Figure 5* is χίχα [çixa], a non-word that caused problems for almost every participant. The accurate production of the non-word by a Greek monolingual is presented in spectrogram a). The encircled dark formants depict the [ç] and [x] allophones respectively. The darkest energy of [ç] in the spectrogram is found in significantly higher frequency region than that of [x]. The production of the Heritage Speaker does not differ in the [ç] sound since its formants are also in the high frequency region. The [x] sound, however, differs from the monolinguals production as its darkest

energy is concentrated in a higher frequency region. As far as the bilinguals' production is concerned, the productions of target [ç] and target [x] are totally identical in the spectrogram as they both are on the same frequency level and illustrate that the participant simply repeats the same consonant regardless of the phonological environment. This spectrogram reflects the bilingual's inability to produce the difference between the two phonetic environments, indicating that he is not sure of/aware of the correct allophony rule. Although neither the Heritage Speaker nor the Early Bilingual managed to pronounce this particular non-word correctly, one could observe that the heritage speaker's production is closer to the monolinguals at least as far as the [çi] in the first syllable is concerned, whereas the bilingual's production differs in both syllables. This example reflects the overall performance of the heritage speakers and early bilinguals. The influence of German language on their Greek phonology skills is evident in both groups; however, Heritage speakers' results surpassed those of the early bilinguals in both tasks.
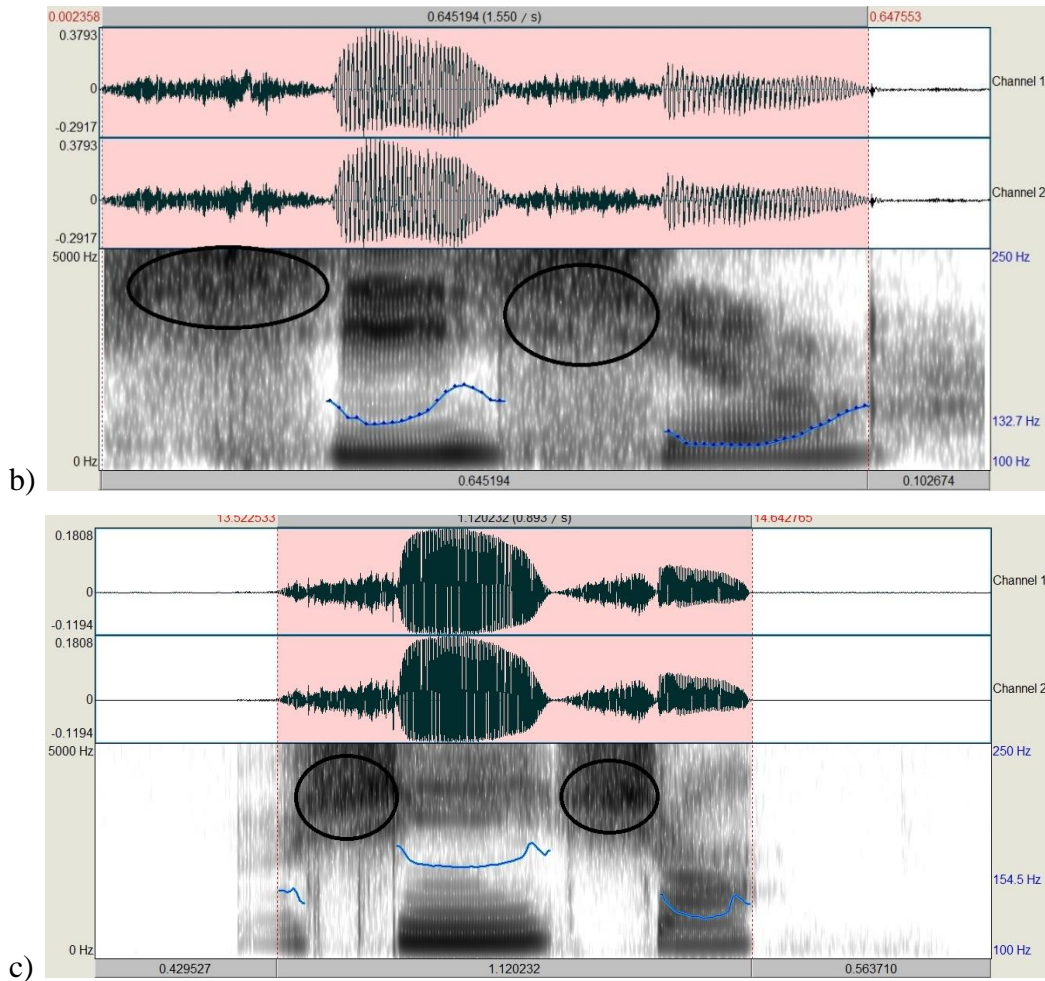

a)
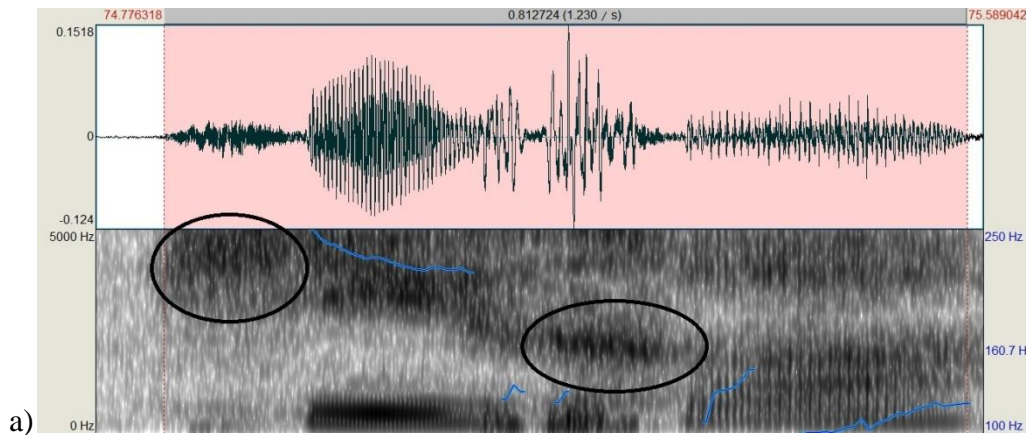
Figure 2: Representations of Praat spectrograms for target production [çixa] (non-word χίχα) as produced by a monolingual a), a Greek heritage speaker b) and an early bilingual)

Greek Heritage Speakers

The first group of participants to be discussed is the Heritage Speaker group. The fact that should be mentioned about the overall scores of this group is that they exhibited particularly high scores of accuracy in the production of words containing the [x]-[ç] allophones. As correct are considered the productions that follow the Greek rules in the application of each allophone. The mean average score in the non-words is 79,2% whereas their accuracy percentage in the words is significantly higher, reaching 90%. The limited number of participants allows us to have a closer look at all of their productions.

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In the following section the results of each participant will be analyzed and discussed. In this part the focus will be placed on the transfer from the German language to the Greek stimuli. As described previously, transfer is considered the substitution of a Greek feature by a German-specific feature or the applications of a German phonological rule in Greek words. In the following two tables (as adapted from Fabiano-Smith & Goldstein 2005) the transfer results of the Heritage Speakers groups are presented in detail. Twelve instances of transfer were found in this group's non-word productions. Out of these, 9 instances were cases where [ç] was incorrectly used and in 3 cases a target [x]was pronounce as [ks], which will be discussed below. The transfer instances in the word productions were far less though, only 3 cases.

Child	Target	Production	Substitute used	Number of occurrences
Child1	[çex] [çix] [çixa]	[çeç] [çiç] [çiça]	[ç]	3
Child 3	[çex] [çixa] [xaçi]	[çeç] [çiça] [çaçi]	[ç]	3
	[lix] [lex] [pex]	[liks] [leks] [peks]	[ks]	3
Child 6	[çex] [çix] [çixa]	[çeç] [çiç] [çiça]	[ç]	3
TOTAL :	12			

Table 6: Transfer instances in the non-word productions of Heritage Speakers.

Child	Target	Production	Substitute used	Number of occurrences
Child 1	-	-	-	0
Child 3	[taçis]	[taxis]	[x]	1
Child 6	[taçis] [açinos]	[taxis] [axinos]	[x]	2
TOTAL:	3			

Table 7: Transfer instances in the word productions of Heritage Speakers.

Child 1

The instances of transfer from German to Greek were only three out of sixteen which was the highest accuracy score among the participants. More specifically, he replaced [x] with [ç] in the following non-words: χεχ [çe<u>x</u>], χίχα [çi<u>x</u>a] and χίχ [çi<u>x</u>]. His score in the real words was 100% accurate. All the words he was requested to utter were correctly pronounced. No trace of transfer was found in his word productions. The results of this participant denote that the influence of the German phonological skills on his Greek ones is present but limited - to non-words. The participant perceives and knows the differences between the two phonologies and he rarely makes cross-linguistic errors in this particular task.

Child 3

The second child in this category scored 10 accurate productions out of the 16 non-words. Among them were also two non-words that were mispronounced in a similar way by the first child, χέχ [çex] and χίχα [çixa] whereby he also substituted the target [x] with the [ç]. Besides these she also replaced the target [x] allophone with [ç] in χάχι [xaçi]. It is worth noticing that in the non-words λίχ [lix], λέχ [lex] and πέχ [pex] that were the first stimuli to be presented, the participant pronounced the target [x] as [ks], influenced by the Roman alphabet. These three words were counted as simple reading errors and not as transfer ones. As the task was proceeding the participant dropped this production and adopted the expected one [x] or [ç]. The number of correct pronunciations in the real words was almost as high as that of the first participant. Only one instance of transfer was observed, in the word ταχύς [taçis] 'fast' where the child substituted the [ç] with the [x], resulting in [taxis]. Another interesting fact is that she tended to lengthen the vowels preceding the requested allophone which can be interpreted as uncertainty regarding the choice of the correct allophone. A depiction of this vowel length extension along with other strategies employed by the participants will be presented in detail in a separate section below. Conclusively, the second participant performed less well than the first one in the non-words task, as she needed more time to get acquainted to the Greek

alphabet and to adapt to the language switch from German to Greek. However, her score in the real word task was similar to the first participant, since she only presented one instance of transfer.

Child 6

This particular participant reached a high accuracy percentage (87,5%) in the non-word productions. The non-words χίχα [çixa] and χέχ [çex] were mispronounced, and again the target [x] was replaced by the [ç] allophone. As far as the real words are concerned, the words ταχύς [taçis] 'fast' and αχινός [açinos] 'urchin' were the ones which caused confusion in this participant and she used the [x] allophone instead of the target [ç]. Another interesting feature of this participant was her self-monitoring. The participant corrected herself intuitively when uttering a non-word. For instance, although she initially started transferring the German rule to the [açi] part of αχινός, she blocked this transfer by herself and eventually applied the Greek rule providing a correct production of the real word. This participant monitored her speech repeatedly also in the non-words πόχι [poçi] and χέχ [çex]. This strategy suggests that her Greek phonological skills are undergoing a stabilization process.

To sum up, Child 1 and Child 6 exhibited high rates of accuracy in the choice of allophones [x]-[ç]. That is, they produced the Greek words and non-words according to the Greek allophony rule. Child 3 had a low performance in the non-words part but presented equally high results in the real word productions. Interestingly, the non-words χίχ [çix], χεχ [çex], and χάχι [xaçi] confused the participants, probably because there were two instances of the character 'χ', thus involving two allophone choices. As far as the transfer is concerned, 12 occurrences of transfer were recorded in the non-word productions out of the 48 target words. In 9 cases [ç]was used instead of [x], whereas [ks] was used in the other 3 cases. With regard to the word productions, the results are better since only 3 instances of transfer were observed. Surprisingly, in these cases it was [x] that was used instead of correct [ç]. These results suggest that for the real words, participants make use of stored, correct motor patterns. The non-words, requiring an on-the-spot choice for a specific allophone and the construction of a motor pattern however, show a slight influence of the German phonological rule.

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Early bilinguals

This group's performance was, as previously mentioned, lower compared to the performance of the group of the heritage speakers. Again, the focal point of this part will be the number of substitutions to be counted as transfer. In *Tables 8* and *9* these data are illustrated.

Child	Target	Production	Substitute used	Number of occurrences
Child 2	[xaçi] [çix] [çixa] [pixo] [ixo] [ixa] [çex] [pex] [lex]	[çaçi] [çiç] [çiça] [piço] [iço] [iça] [çeç] [peç] [leç]	[ç]	9
Child 4	[çex] [çix] [kix]	[çeç] [çiç] [kiç]	[ç]	3
	[xaçi]	[xaxi]	[x]	1
Child 5	[lix] [çex] [çix] [çixa]	[liç] [çeç] [çiç] [çiça]	[ç]	4
	[açi] [xaçi]	[axi] [xaxi]	[x]	2
TOTAL :	19			

Table 8: Transfer results in Early Bilinguals' non-word productions.

Child	Target	Production	Substitute used	Number of occurrences
Child 2	[xara] [rixardos] [mixani] [exo]	[çara] [riçardos] [miçani] [eço]	[ç]	4
Child 4	[vroçi] [maçi]	[vroxi] [maxi]	[x]	2
Child 5	[koçili] [vroçi]	[koxili] [vroxi]	[x]	2
TOTAL :	8			

Table 9: Transfer results in the Early Bilinguals' real word productions.

Overall, the number of transfer occurrences in this group is higher than in the previous group. Nineteen transfer occurrences were found in the early bilinguals' non-word productions compared to 9 in the heritage speakers' data. In the second task the transfer numbers decreased to 9, but still the heritage speakers provided only 3 such cases. The results of each participant are presented below.

Child 2

This participant presented the lowest accuracy scores of the participants. He achieved only 43,8% accuracy in the non-word productions and 77,7% in the real word productions. He exhibited a preference in using the [ç] allophone regardless of the context and the non-words that were pronounced correctly were non-words that would require the [ç] allophone. Thus, one could conclude that this participant simply overused the [ç] allophone as a strategy to avoid making decision about the correct allophone to use. It is worth highlighting that this participant is the youngest of both groups. (7;2).

Child 4

This participant achieved a higher score of accuracy in his productions than the first one. Twelve out of the 16 in total non-words were produced accurately. The non-

words χάχι [xaçi], χίχ [çix], χέχ [çex] and κίχ [kix] caused difficulty for this participant, probably because - except for κίχ - two decisions about allophones had to be made. As recorded in this task, the [ç] allophone was erroneously used instead of [x] 3 times, while the opposite error occurred only once. His results in the production of the real words were better since only two words were mispronounced namely, βροχή [vroçi] 'rain' and μάχη [maçi] 'battle'. Similarly to the Heritage speakers group, [x] was used as a substitute in both productions. The results of this participant are only slightly under the mean score of the Heritage speakers group.

Child 5

The last participant in the group of the early bilinguals exhibited a similar performance. His results of the non-word productions were equally low: 11 out of 16 non-words were pronounced correctly. The non-words λίχ [lix], άχι [açi], χάχι [xaçi], χίχ [çix] and χίχα [çixa] were mispronounced. Again, the results of the word productions were better. Only two out of the eighteen words were mispronounced, namely, κοχύλι [koçili] 'shell' and βροχή [vroçi] 'rain' which in both cases were pronounced with the [x] allophone. It is also of major importance that this participant too seems to self-correct himself as illustrated with the word ταχύς [taçis] 'fast' in *Figure 9*. Although the participant initially starts pronouncing the word with incorrect /x/ he then re-utters it correctly using the appropriate allophone.

Summary

Taking the above results and numbers into consideration, an important outcome is the difference in accuracy in the production of non-words and words. Both groups seem to automatically transfer the non-words to the German phonological system and produce them accordingly. This also constitutes the main difference between the heritage speakers and the early bilinguals. As exhibited in the results above the Greek heritage speakers had higher scores of accuracy in the production of non-words compared to the early bilinguals.

These results can be interpreted as being indicative of the dominant system. Since the participants intuitively choose the German rules in production of non-words this

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implies that any element that is not familiar to them will be categorized according to the German phonological system. The fact that one caregiver is of German origin also plays a contributing role in relative dominance of both Greek and German phonologies of the Early bilingual children. As far as the production of the real words is concerned, the differences between the two groups were really subtle, with the exception of one participant who appeared to use a strategy to avoid choosing between the two contradicting systems. His young age could have contributed to his production errors, and his accuracy might improve with experience. As far as Child 3 is concerned, she had the lowest accuracy score among the participants of her group. Her non-word results were even lower than those of some early bilinguals. Six instances of transfer were observed in her non-word productions. However, her real word productions were more accurate than those of the early bilinguals. This may be due to the language experience she has had as she has the highest input percentages among the rest of the participants (39%).

For all the participants the presence of two "χ" orthographic characters in a word to be produced seemed to cause a lot of difficulty. It is not coincidental that none of the participants could accurately produce the non-word 'χίχα'. All of the participants again tended to spread the palatalization to the following syllable pronouncing it as [çiça] instead of [çixa]. Similar results were reported also with the non-word 'χίχ'. The majority of the participants applied the palatalization rule to both instances of the character "χ". These errors, however, may also reflect a repetition problem rather than a problem with applying the correct rule. A common feature in all of the above mentioned cases that should be underlined is that in most of the cases the allophone [ç] is used incorrectly instead of [x], and only in few cases the opposite occurred - and mainly in real word productions. The reason for this attitude may have its roots in the higher frequency of occurrence of the [ç] sound in German, especially in word-final position, like in 'Pech' /peç/ 'bad luck' and 'frech' /freç/ 'rude'. This can partially explain the choice of allophones in the non-words 'χέχ' and 'χίχ'. On the other hand, the tendency of 4 out of the 6 participants to use [x] instead of [ç] may be related again to this characteristic of the German phonology. Since [ç] rarely appears in medial position, the participants may therefore prefer [x]. However, the limited amount of results does for now not provide enough evidence for this hypothesis.

Underlying /sm/ consonant sequence

In the second part of the experiment the phenomenon under investigation is the voicing assimilation in clusters of /s/ followed by a voiced consonant, present in the phonology of Greek, but largely absent in the phonology of German. In German, the /sm/ cluster does not appear at the word onset. Target /sm/ clusters only appear in the middle of words of Latin origin i.e. Kommunismus [komunizmus] 'communism', across a syllable boundary, and only in such cases they are pronounced [zm]. This phenomenon is limited to these words and does not comprise an original feature of German phonology since voicing assimilation is a phenomenon that does not exist in the language in general (Wetzels & Mascaro, 2001). In Greek the phoneme /s/ is represented by the orthographic character 'σ'. When it precedes vowels or voiceless consonants it is uttered as [s]. When it precedes voiced consonants such as [m], [γ] or [β] then it also becomes voiced and it is pronounced as [z]. Voicing is thus spread from the voiced consonant back onto the sibilant fricative. The results of the production task involving /s/ followed by a voiced consonant will be presented separately for each participant.

In *Table 10* the scores of the two groups in the voicing assimilation task are illustrated. The scores for both groups in this task are significantly lower than those for the previous task. Out of the 39 productions including the /sm/ consonant sequence, only 9 were produced correctly by the Heritage Speakers. The score for the Early Bilinguals is similarly low and the total number of their accurate productions is 8 out of 39. The results of each participant will be presented individually.

Testing the voicing assimilation rule					
Heritage Speakers			**Early Bilinguals**		
Ch1	**Ch3**	**Ch6**	**Ch2**	**Ch4**	**Ch5**
4/13	1/13	4/13	3/13	3/13	2/13
TOTAL:	**9/39**			**8/39**	

Table 10: The accuracy scores of both groups for the voicing assimilation task.

Monolinguals vs Bilinguals

Before proceeding with each participant separately we will examine the productions of each bilingual group and compare it to the productions of monolinguals. In this task the accuracy percentages of both bilingual groups are extremely low compared to those of the monolinguals. The overall accuracy score is 20,4% for the early bilinguals and 22,9% for the heritage speakers. Again the monolingual group did not have any difficulty with the stimuli and had a 100% accuracy score, since voicing was evident in all the productions. As correct were considered the productions that complied with the Greek voicing assimilation rule. Similarly to the analysis of the previous task and in alignment with the substitution error analysis by Fabiano-Smith and Goldstein (2010) an error was considered a transfer error when the German rule was applied instead of the Greek one i.e. [ʃm] was produced instead of [zm], or when they break the sequence by inserting a pause, like [as.vos] instead of [azvos]. When both rules were applied in one word productions (i.e. [aʃ.vos]) then they were counted as two instances of transfer. Interestingly enough, three substitution patterns where identified in the productions of the words, namely, the production of [ʃ] or a voiceless [s] instead of [z], and a pause between the [s] and [m]. The Tables *11* and 12 below provide an overview of the transfer results in both groups.

Child	[s]	Pause	[ʃ]	Number of occurrences
Child 1	[smaragdi] [aŋkaliasma] [kaθisma] [smaro]	[muʃ.mulo]	[muʃ.mulo] [aʃma] [ʃminos]	8
Child 3	[smaragdi] [aŋkaliasma] [kaθisma] [smaro] [sminos]	-	[aʃma]	10

	[kosmos] [ifasma] [fantasma] [musmulo]			
Child 6	[smaragdi] [aŋkaliasma] [kaθisma] [smaro] [kosmos]	[muz.mulo]	[aʃma] .	7
TOTAL:	25			

Table 11: Patterns of transfer in the productions of Greek Heritage speakers.

Child	[s]	Pause	[ʃ]	Number of occurrences
Child 2	[smaragdi] [aŋkaliasma] [smaro] [sminos] [kosmos] [musmulo]	[kos.mos] [mus.mulo]	[aʃma]	10
Child 4	[smaragdi] [aŋkaliasma] [smaro] [sminos] [musmulo] [kos.mos] [fantas.ma] [as.ma]	[kos.mos] [fantas.ma] [as.ma]	-	11
Child 5	[smaragdi] [aŋkaliasma] [fantas.ma] [as.ma]	[mus.mulo] [koʃ.mos] [ʃmaro]	[ʃminos] [koʃ.mos]	10

TOTAL:	31

Table 12: Patterns of transfer in the production of Early bilingual children.

The results of this task showed a great difference in the number of transfer occurrences compared to the previous task. The number of transfer instances is high for both groups and again the Greek Heritage Speakers performed somewhat better, presenting 25 such instances, than the Early bilinguals who showed 31. The German [ʃ] and pause between the syllables /./ as well as producing [s] were the German-specific patterns, identified through phonetical analysis in PRAAT, and were frequently used by both groups. A specific preference for voiceless [s] was observed. In this task the influence of German on the Greek phonological skills of the children was more than evident. Interestingly enough, children show a tendency to adapt the Greek phonological rule to the German one by inserting a pause or by employing a consonant that appears frequently in this position.

Greek Heritage Speakers.

Child 1

Despite the extremely high accuracy in the [x]-[ç] task, this participant exhibited extreme low accuracy in the productions of the consonant sequences, with a high number of transfer instances. More particularly, out of the 10 tokens he was requested to utter he managed to provide only 3 correct answers, for ύφασμα [ifazma] 'cloth', κόσμος [kozmos] 'world' and φάντασμα [fantazma] 'ghost'. The rest of the words were produced without the (obligatory) voicing of /s/.

Child 3

This participant did not provide any correct production of the requested cluster. Regardless of its position in the word either in initial or medial position the participant failed to give any correct answer and failed to implement the voicing assimilation rule. Instead, she exhibited a real preference for voiceless [s].

Child 6

In alignment with the low accuracy results of the other participants from the heritage speakers group, this participant pronounced only 3 words correctly. Similarly to the previous participants, he also showed a tendency in using the [s] instead of the requested [z].

Early bilinguals

Similarly to the group of heritage speakers, the early bilinguals' group did not perform very well in the production of voicing assimilation in the requested words and non-words and an equally significant preference for the [s] is documented.

<u>Child 2</u>

This participant, as previously mentioned, is the youngest of all (7;1). He is the only one who uses more frequently the German sound [ʃ] in the production of the Greek words, like in the word σμήνος [ʃminos]. However, in 3 out of 10 words the participant produced the [zm] cluster correctly, implementing the voicing assimilation. In the majority of the rest of the words [s] was employed.

<u>Child 4</u>

This participant used the pausing option strategy in 3 out of the 10 words, namely in άσμα [as.ma], κόσμος [kos.mos], and φάντασμα [fantas.ma]. In total the participant provided only 2 out of 10 correct [zm] productions, using mostly [s].

<u>Child 5</u>

The last participant of the early bilinguals also exhibited a low score in the /sm/ clusters. In some cases, he appeared to delete the /s/ preceding the voiced consonant producing for instance [minos] instead of [zminos]. In addition to that, pausing traces was also to be detected in her speech i.e. [koʃ.mos] instead of [kozmos] along with /ʃ/ implementation. /ifazma/ and /fantazma/ were the only words that elicitated the voicing assimilation and the rest were pronounced without the voicing, simply with /s/ consonant.

Extra words

Since the performance of the participants was extremely low and in order to cross check the results three more words were added to the initial list which also required voicing assimilation but in a different consonant sequence, namely, but the /sg/ and the /sv/. The words added to the list are the words σγουρός [zguros] 'curly', σβούρα [zvura] 'pinwheel', and ασβός [azvos] 'badger', presented in Table 13. This could provide evidence of whether the participants face a problem with a specific consonant cluster or with voicing assimilation in general.

Target Productions	Actual Productions Heritage Speakers	Actual Productions Early Bilinguals
[zguros]	**Ch1** [sguros], [asvos], [zvura]	**Ch2** [sguros], [asvos], [svura]
[zvura]	**Ch3** [zguros], [asvos], [svura]	**Ch4** [sguros], [azvos], [svura]
[azvos]	**Ch6** [sguros], [az.vos], [svura]	**Ch5** [sguros], [as.vos], [svura]

Table 13: Actual Productions of the extra words by both groups.

The influence of the phonology of German on the Greek productions in the whole task, i.e. including both the words with underlying /sm/ sequences and the extra words, is more than evident. The participants seemed really confused when dealing with these sequences and this is reflected in their really low accuracy scores in the production of the words. Despite the fact that [zm] appears in specific cases in German, the participants failed to apply the Greek voicing assimilation rule in the real words. Instead, they were either replacing the fricative with the German fricative [ʃ] (Figure 12b), or avoiding the use of [s] (Figure 12c), or they were simply not voicing the [s] which was the most common way to produce underlying /s/ (Figure 12d). Another strategy that was observed in the productions of many participants, like in the previous allophonic task, is the pausing between the syllables. In *Figure 12d* the interval circled between the [s] and [m] sound denotes this syllable-by-syllable reading of the word. Instances of these attitudes in the same word are presented in the Figures below, along with the target production of the

Greek production [zminos] from a monolingual (Figure l2a). The basic features that should be noticed in these examples are the voicing of the cluster and the duration of the underlying /s/. The voicing of a sound is illustrated in a spectrogram with the dense voice bars at the bottom of the frequency spectrum. According to previous studies, (Jongman Wayland & Wong, 2000; Nirgiannaki, 2014) the main difference between the /s/ and /ʃ/ lies in the duration of the consonant since the second one is significantly longer than the first. Thus, taking into consideration these two features one can determine the actual productions of the participants. The density in voice bar is absent in all productions compared to the productions of the monolingual speaker one. Besides, in *12b* and *12d* the duration of the [s] is longer than that of the [s] produced by the monolingual speaker, making it sound like the [ʃ]. This probably has also its roots in German, where [ʃ] commonly appears in a word-initial position. Thus, these results function as indicators that the absence of a phonological feature in the dominant language indeed affects the minority language, since it promotes the elimination of this feature in the minority language. This task validates our initial hypothesis concerning the dissimilarity between the two languages of the bilinguals. A feature that is dissimilar or not shared in the bilinguals' two languages is more difficult to be acquired. The findings align with the previous studies claiming that shared sounds demonstrate higher accuracy rates than the unshared ones. (Fabiano, 2006; Fabiano & Goldstein 2005). Indeed a sound that is not common in German is more difficult to produce correctly in Greek, by both groups, than the [x]- [ç] allophones that are present in both languages, even if they appear in opposite phonological environments.

a)   [zminos]

b)   [ʃminos]
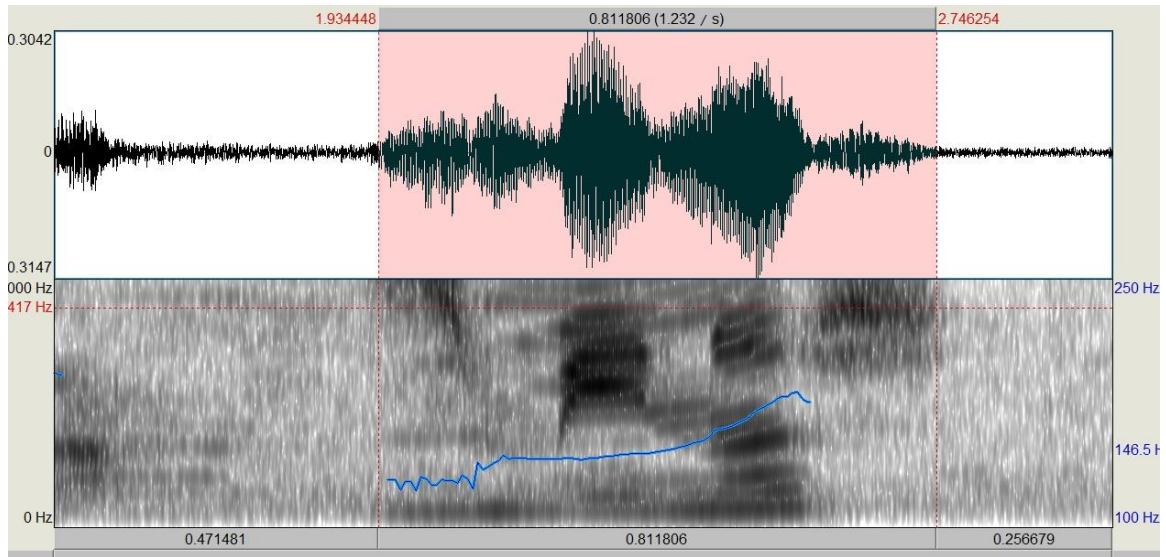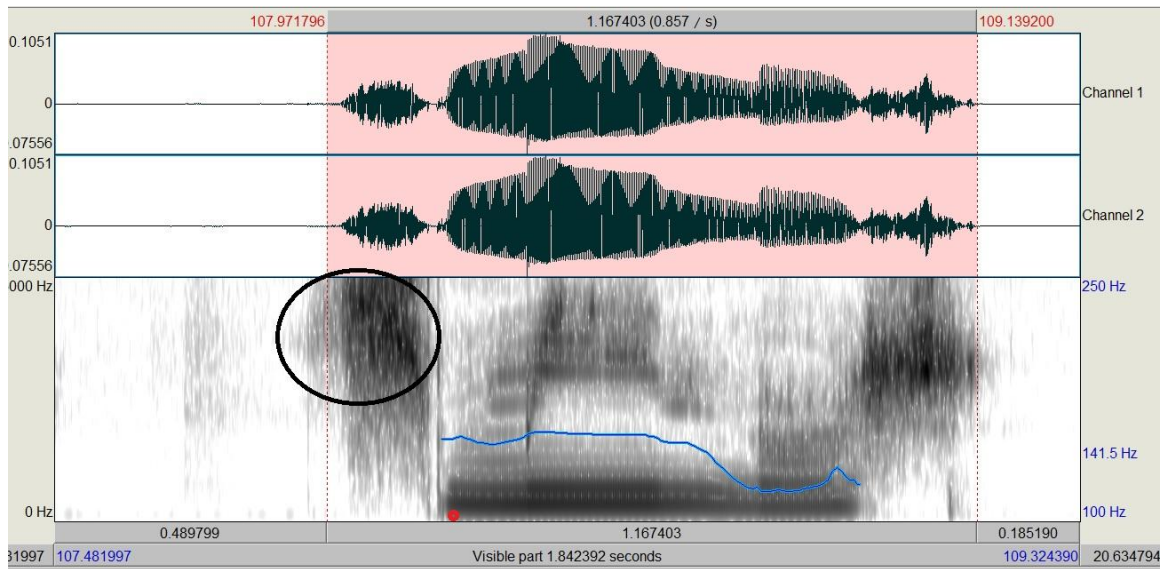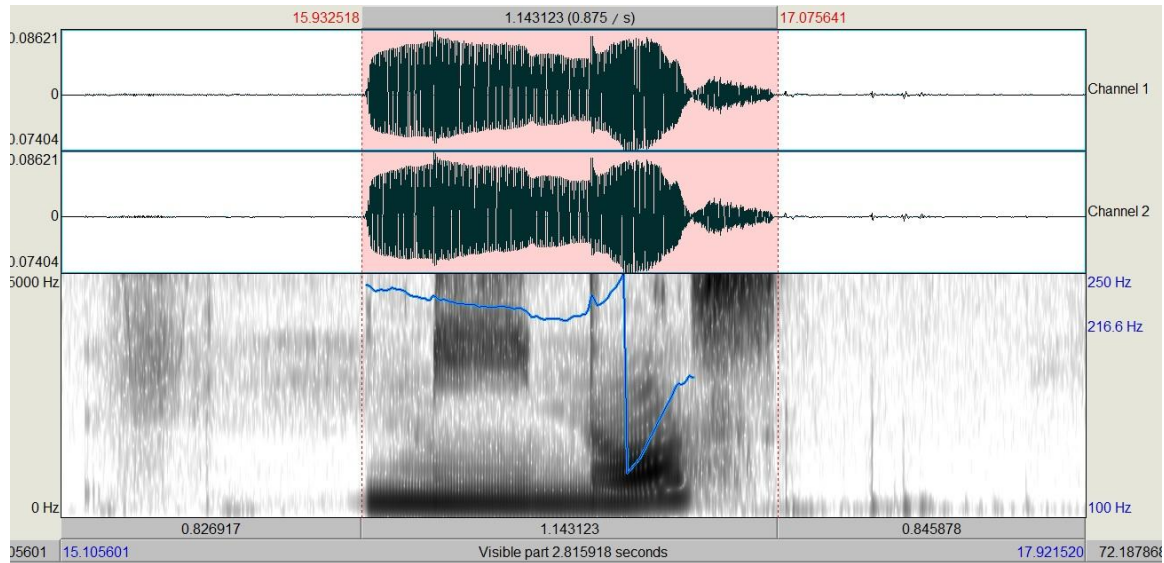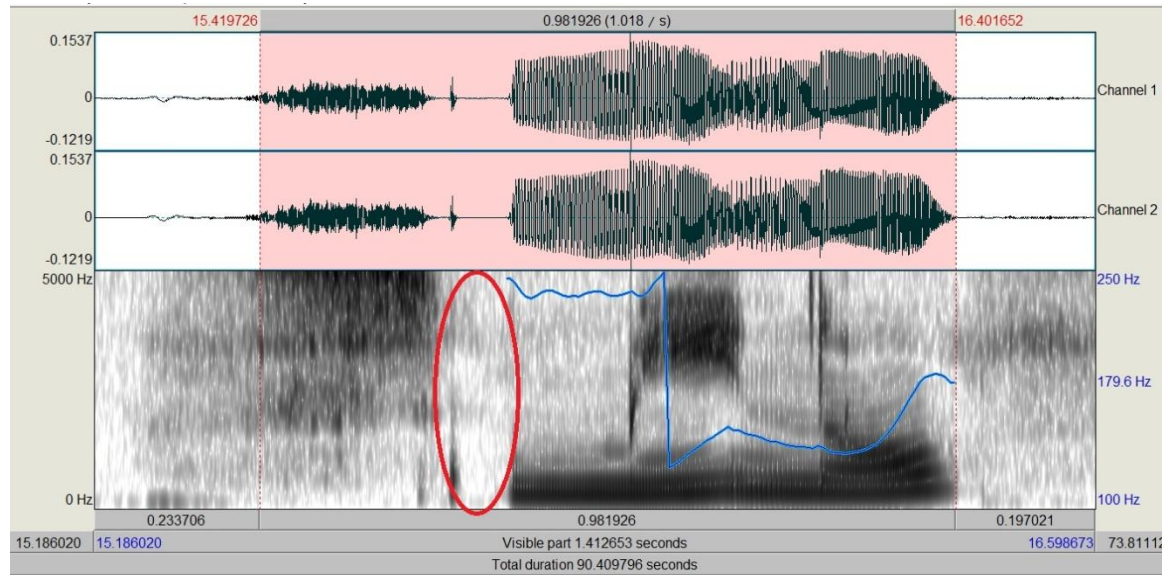
c) [minos]

d) [ʃ.minos]

Figure 3: Representations of Praat spectrograms for productions of underlying /sminos/ as produced by a monolingual a), two bilinguals b), c) and a Greek heritage speaker d).

Strategies

Apart from the accuracy scores that are documented for this task it is worth referring to the strategies that the participants employed in general in order to deal with

each sound in each task. These strategies were mainly employed because of the participants 'confusion and are summarized below.

Vowel length extension

Three participants extended the vowel length before the production of the allophones [x] or [ç]. This uncertainty concerning the choice of allophone can be explained as uncertainty about the phonological rule that had to be applied in Greek. In *Figure 4* a spectrogram illustrating this strategy is exhibited. In the word τοίχος [tixos] the lengthening preceding the [x] allophone is denoted with a red arrow.
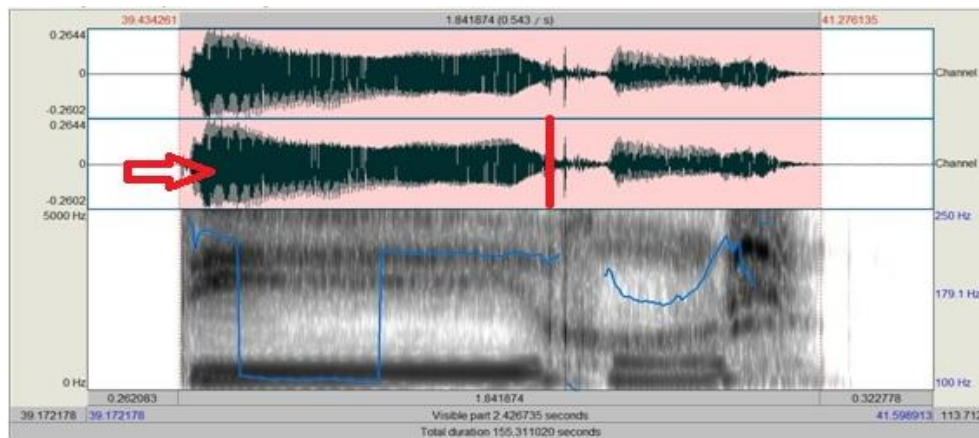
Figure 4: Praat spectrogram illustrating vowel length extension in the production of [tixos] as produced by a Greek Heritage Speaker.

Pausing

Another strategy the participants adopted when dealing with the features is pausing between the syllables in the words. They were uttering the word syllable by syllable which again helped them gain more time to think about the rule and choosing the appropriate allophone. In *Figure 5* a sample of this attitude is presented. The long interval circled in the spectrogram depicts the gap between the two syllables.
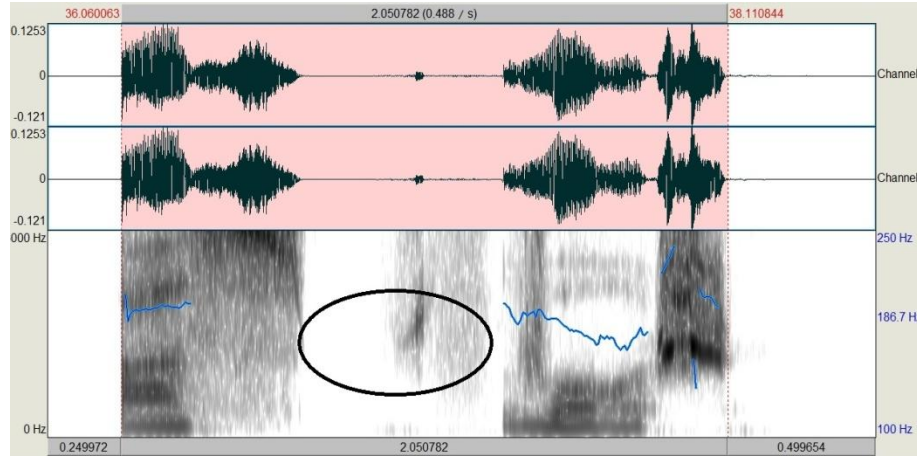
Figure 5: Praat spectrogram illustrating the syllable "by" syllable production of the word [az.vos] as produced by a heritage speaker.

Self-correction

Last but not least, some of the participants were correcting themselves at the time of speaking and while they started using the wrong allophone they replaced it with the appropriate one in the middle of the utterance. As illustrated in *Figure 6* the long interval between the two sounds indicates the blocking of the transfer of the German rule in the Greek word. More precisely this change is also indicated by the change of the frequency of the dark formants. As reported earlier, the normal position of the formants for the [x] production is between 2500Hz and 3000Hz, while for [ç] ranges from 4000Hz to 5000Hz. The monitoring of this participant and his change from [x] to [ç] is reflected by this sudden change from lower frequency levels to higher ones.
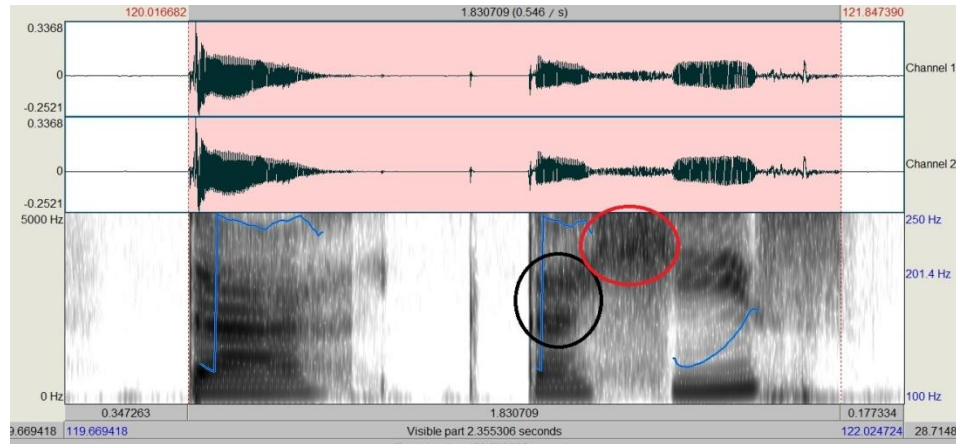
Figure 6: Praat spectrogram illustrating self correction in [taxçis]
as produced by an early bilingual.

4. **<u>DISCUSSION</u>**

The aim of this study was to raise awareness with regard to the phonological acquisition of the Early Greek-German bilinguals as compared to the groups of the Greek heritage speakers. Both groups are born and raised in Germany. In order to evaluate the phonological skills of these two groups, they were examined in their ability to deal with the [ç]-[x] allophones and the /sm/ consonant sequence in Greek. The results of both groups were discussed in the light of Flege's SLM Hypothesis (1995) and Genesee and Paradis' Interdependence Hypothesis (1996).

It was predicted that both the Heritage Speakers and the Early bilinguals' groups would make errors in the production of the Greek words involving the particular aspects because of the interaction with German. Thus, compared to the Greek, typically developed monolinguals, who were capable of providing accurate productions both groups were expected to exhibit a delay in the acquisition of these features. The delay or deceleration (Genesee & Paradis, 1996), results from the interaction between the two languages. The Greek heritage speakers were expected to have a higher level of accuracy in their productions because until the age of 4 they were exposed to the Greek language only. On the contrary, a lower accuracy level was expected for the Early Bilinguals since

from their birth on they received input in both languages, but their exposure to German had always surpassed their exposure to Greek. Both expectations, in alignment with Barlow's results (2014) were affirmed. The overall accuracy percentages of the Heritage Speakers, especially Child 1 and Child 6, in both tasks indeed exceeded those of the Early Bilinguals. All in all the Early Bilinguals showed twice as many transfer cases were than the Heritage Speakers. However, in the second task, involving voicing assimilation, the results were equally low for both groups. The extra exposure the Heritage Speakers might have received did not facilitate the acquisition of the [zm] consonant cluster. Thus, the linkage between exposure and performance is less clear for this sequence. Of course, it is currently unknown how much exposure the Heritage speakers and the Early Bilinguals actually have to this particular typo of sequence. A larger population, and information about the exposure to the particular sequences should provide more evidence for this interaction between exposure and performance.

The expectations for two phonological aspects differed. For the [x]-[ç] allophones it was expected, based on Barlow's (2014) paradigm, that both groups would transfer the German allophonic rule to the Greek words. However, the fact that these allophones follow competing phonological patterns in each language could obstruct the transfer process and result in a confusion of the child about the implementation of each allophone in each language. Indeed, not all the participants appeared to transfer from German to Greek, which proves that the competing rule indeed had a blocking effect on a potential transfer, especially to the group of the Heritage Speakers. In order to deal with this confusion, the participants used strategies like overgeneralization/overuse of one of the allophones like (Child 2), deletion of the feature being investigated (Child 5) and syllable-by-syllable reading (Child 3). The hesitation and lack of confidence about the employment of the allophones, as reported in the study, are the result of this uncertainty about the application of the correct phonological rules.

The expectations about the underlying /sm/ consonant sequences above differed. Compared to the [ç]-[x] allophones, which emerge in the phonologies of both languages, a /sm/ sequence, and the voicing assimilation rule in general, are phenomena that exist in German, but only across a syllable boundary. In Barlow's paper (2014) the phenomenon

investigated was the transfer of a phonological feature that was present in the dominant language but absent in the minority language. In the present study the condition is the opposite. Based on the results collected from the English-Spanish participants by Barlow it was therefore expected that the absence of a feature of a dominant language would cause the elimination of this feature in the heritage language. This hypothesis is validated in the present study, since the participants did not apply the voicing feature in the Greek words involving the [sm] sequence.

The results of this study function as an indicator of the way Greek heritage speakers and early Greek-German bilinguals deal with the phonological differences between the two languages. Although the number of participants is low, the data collected do invite further studies on this population and topic. Children exhibited signs of confusion in the implementation of the appropriate rule in the appropriate environment. Thus, a large-scale experiment with a larger number of participants is of great importance in order to complete the puzzle of phonological acquisition in this population. This study provides some evidence of transfer as well as information concerning identical allophones that appear in contrasting environments, and concerning a feature that is present in the minority language, but largely absent in the dominant language of the participants. The results in both tasks of this small study show that these are interesting topics to pursue in future research. Most of the participants experienced a slight confusion when they had to use the shared allophones and a greater one when they had to deal with the unshared voicing assimilation. This confusion highlights the need of attentive bilingual instruction that will assist the bilinguals to perceive and understand the (minimal) phonological difference between the two languages. According to the data presented in previous studies (Panhellenic Association of Logopeadics 1995; Papadopoulou 2000) a typically developing monolingual is supposed to acquire the [x] allophone between 3-4 years of age, the [ç]- allophone at the age of 4, and the sequence [zm] between 4 and 4;6 years of age. Taking into consideration the results of the current study, a deceleration in the acquisition of those features and especially of the sequence [zm] was found in both groups, highlighting the need for directed instruction.

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APPENDIX

Questionnaire as adapted by Mortrul (2012)

NH_RC

National Heritage Language Resource Center

Title: *Background questionnaire for Greek/German speakers*

As adapted by: Silvina Montrul

Date: 2012

http://www.nhlrc.ucla.edu/data/questionnaires.asp

(This information will be kept confidential)

Participant research ID number: _____

Age: _____

Telephone number or e-mail:_____

∎∎

I. Personal Data

What is your highest level of education completed? (please circle):

some high school   high school   some college   college graduate

Country of origin: _____

Country of current residence:_____

1. If you were not born in Germany, during what ages did you live in your country of origin?

2. If you were not born in Germany, how long have you lived in Germany for?

****

II. Family History

1. Where are your parents/caregivers from?

    Mother: _____   Father:_____

2. What languages do your parents/caregivers speak?

    Mother: _____   Father:_____

****

III. Your Linguistic History

3. At what age did you first begin to learn German?

4. Did you begin to speak both German and Greek before age 5?

    Yes   No

****

Daily Life

5. How often do you use German during the day?

    One hour   4 hours   8 hours   the whole day (90%)

6. Who do you speak German with?

mother/father   siblings   friends   colleagues

7. Who do you speak Greek with?

Mother/father   siblings   children   colleagues

8. Did you attend elementary school in Germany?

Yes   No

9. Was German the primary language of instruction?

Yes   No

10. Did you have German as a foreign/second language in elementary school?

Yes   No

11. What language did you speak with your child at home?

Greek   German   Mixed   Both

Child's Linguistic Background

12. Who does your child speak German with?

mother/father   siblings   friends   others

13. Who does your child speak Greek with?

Mother/father   siblings   friends   others

14. What is the primary language of instruction in school?

Greek   German

15. How many hours (approximately) does s/he spend speaking in Greek?

1 hours   4 hours   8 hours   the whole day

16. How many hours a week of Greek does your child attend in middle school?

2 hours   5 hours   10 hours   more than 10 hours

17. Has s/he ever encountered any kind of difficulties in language learning?

Yes   No

****

VII. Your linguistic proficiency now

17. Rate your current overall language ability in GREEK

 1 = understand but cannot speak

 2 = understand and can speak with great difficulty

 3 = understand and speak but with some difficulty

 4 = understand and speak comfortably, with little difficulty

 5 = understand and speak fluently like a native speaker

18. Rate your current overall language ability in GERMAN

 1 = understand but cannot speak

 2 = understand and can speak with great difficulty

 3 = understand and speak but with some difficulty

 4 = understand and speak comfortably, with little difficulty

 5 = understand and speak fluently like a native speaker

19. On a scale from 1 to 5, rate your child's abilities in Greek and in German

 (1 =poor; 2= needs work; 3=good; 4= very good; 5= native speaker command)

 Greek Reading =   Speaking=   Listening=   Writing=

 German   Reading =   Speaking=   Listening=   Writing=

20. In general, which language does your child prefer to use? (circle one)

 Greek   German   It depends   Both

on whom I talk to

21. Which language do you prefer to use with your child?

Greek   German   It depends   Both

22. Do you feel Greek is your native language or like a second language?

Native language   second language

23. Would you like to improve your Greek language skills?

Yes   No

24. What would you like to improve about your German language ability?

25. Do you think you will use more German in your future?

****
****

VIII. Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____