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Production and perception of the English /h/: the case of native Portuguese speakers of English as a Foreign Language

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To my parents and brother,

Sources of endless love, support and happiness.

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-What happens when people open their hearts?

-They get better.

Haruki Murakami

ABSTRACT

Production and perception of the English /h/: the case of native Portuguese speakers of English as a Foreign Language

When learning English as a Foreign Language (EFL) Portuguese speakers tend to have some difficulties in the production of certain English sounds (Koerich, 2002; Kluge, Rauber, Reis & Bion, 2007; Reis, 2010; Rato, 2013; Osborne, 2015), including /h/, which does not exist in the Portuguese phonological system. Therefore, it may be considered a "new" sound according to Flege's Speech Learning Model (1995). In the Portuguese language, the <h> is silent. Two types of production deviations have been reported regarding the production of English /h/ by native speakers of Romance languages, namely hypercorrection and/or omission (John & Cardoso, 2007). They tend to either produce /h/ in phonemic contexts in which it does not occur in English (e.g.: *I hurt my* [h]*ankle*) or not produce the voiceless glottal fricative at the beginning of the word. Although these deviations have been investigated in terms of pronunciation, few studies have examined perception, and most importantly, the link between production and perception. Therefore, the present study investigates the production and perception of English /h/ by Portuguese speakers of English to describe the most common types of misproductions, to analyse potential perceptual difficulties in the discrimination and identification of the target sound, and to examine whether inaccuracies in production correlate with perceptual problems.

The experimental study examined the production and perception of English /h/ by 38 Native Portuguese. Participants had to perform four main tasks: two focused on the production of /h/ in isolated words and in context while the other two examined these L2 learners' ability to identify and distinguish the phoneme. The results show that a great majority of the L2 learners produced the new phoneme accurately and that /h/ is better produced in isolation rather than in context. Nevertheless, instances of /h/ insertion occurred more frequently in the word-reading task and h-deletion in the picture story narration. Perception data shows that L2 learners were able to recognize the phonetic features involved in the realization of English /h/, thus establishing a new phonemic category in their L2 inventory. Furthermore, a link between these two speech domains was found as their results are so close and a significant difference was not found.

RESUMO

Produção e perceção de /h/ no Inglês: o caso de Portugueses nativos que têm o Inglês como segunda língua.

Ao aprender Inglês como Língua Estrangeira, Portugueses nativos tendem a ter alguma dificuldade na produção de determinados sons Ingleses (Koerich, 2002; Kluge, Rauber, Reis & Bion, 2007; Reis, 2010; Rato, 2013; Osborne, 2015), incluindo /h/, que não existe no sistema fonológico Português. Desta forma, o som pode ser considerado como "novo" de acordo com o Speech Learning Model, proposto por Flege (1995). Na língua Portuguesa, <h> é silenciado. Dois tipos de produção divergentes relacionados com a produção do /h/ Inglês por nativos de línguas românticas têm sido reportados, nomeadamente hipercorrecção e/ou omissão (John & Cardoso, 2007). Falantes nativos destas línguas tendem a produzir /h/ em contextos fonémicos onde não ocorre em Inglês (ex.: */ hurt my* [h]*ankle*) ou então não o produzir no início da palavra. Apesar destas divergências terem sido investigadas em termos de pronúncia, poucos estudos têm examinado a perceção, e mais importante, a ligação entre produção e perceção. Por essa razão, o presente estudo investiga a produção e perceção do /h/ Inglês por Portugueses nativos para descrever os tipos de erro mais comuns na produção, analisar as potenciais dificuldades perceptivas na discriminação e identificação do som-alvo, e examinar se produções erradas estão relacionadas com problemas perceptuais.

O estudo experimental analisa então a produção e perceção do som alvo por 38 Portugueses nativos. Os informantes realizaram 4 testes principais: 2 testes consistiam na produção de /h/ em palavras isoladas e também em contexto e os restantes 2 testes analisam a habilidade dos participantes em identificar e discriminar este mesmo fonema. Os resultados obtidos mostram que grande parte dos L2 aprendentes produziram correctamente o novo fonema, particularmente quando isolado (i.e. no teste de leitura). Contudo, uma maior ocorrência de inserções foi verificada no teste de leitura enquanto a omissão de /h/ teve uma maior percentagem no teste de narração. Os resultados obtidos no teste de perceção mostram que os participantes reconheceram as características fonéticas envolvidas na realização do fricativo surdo Inglês. Além disso, foi verificada uma ligação entre os dois domínios de comunicação visto que não foi encontrada uma diferença significativa entre os dados de produção e perceção.

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List of abbreviations

AOL – Age of learning

AOA – Age of Arrival

CA – Contrastive Analysis

CEFR – Common European Framework of Reference

CHP – Critical Period Hypothesis

CP – Categorical Perception

EFL – English as a Foreign Language

ESL – English as a Second Language

FL – Foreign language

NESs – Native English Speakers

NPSs – Native Portuguese Speakers

LFI – Length of Formal Instruction

L1 – Native language

L2 – Second language

SLA – Second Language Acquisition

SLM – Speech Learning Model

VOT – Voice Onset Time

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INTRODUCTION

It comes as no surprise that English is nowadays considered a universal language and one of the most spoken languages worldwide. Due to globalisation, i.e., the social and economic growth of countries, the notions of multiculturalism and melting pot have become strongly present in our lives and, consequently, English functions as the bridge of linguistic communications between different people, communities and cultures. By living in a world without boundaries, i.e. a global world where you can travel to, and work or study in any country, the acquisition of a second language (L2) becomes extremely important, especially when that language is English.

Nowadays, in Portugal, we are all exposed, indirectly but very frequently, to the English language mainly through the media (Internet, television, radio, films, among others). This amount of exposure to English helps people improve their language skills and facilitates communication, even if speakers' native language (L1), i.e. Portuguese, is not shared (Rubio & Lirola, 2010). Nevertheless, in the professional world, having a certificate that attests one's ability to speak, read, listen and write in English is essential. Although some other languages such as Spanish and Mandarin have the highest number of speakers worldwide, and are becoming important as far as technology is concerned (Godenzzi, 2006; Pak, 2012) , English still keeps its significant status as *lingua franca*.

In the Portuguese national curriculum, English was officially introduced in 2012 in the curriculum of the junior school (i.e. 5th grade of basic education) with an emphasis on oral production. Its introduction in the curriculum of elementary school was optional, that is, the school could decide according to its resources, as stated in the Decree-law n.º 139/2012[1], article n.º9, line 1:

> 1 – As escolas do 1.º ciclo podem, de acordo com os recursos disponíveis, proporcionar a iniciação da língua inglesa, com ênfase na sua expressão oral.

In this sense, in 2012, English classes were taught in primary schools as an extra-curricular subject. The main goal was, and still is, to increase the amount of exposure to the

[1] Diário da República, 1.ª série – N.º 129 – 5 de julho de 2012.

lingua franca and, as a result, improve students' communication skills. As Strecht-Ribeiro explains, "the main objective of modern language teaching is clearly one of communication, that is to say, socialisation, or the interaction between individuals within a social context" (Strecht-Ribeiro, 2005, p. 34).

The implementation of English language learning in the first years of school has come as a result of the partnership between the British Council Portugal and the Portuguese Direcção-Geral da Educação (DGE) in order to promote a sense of a multicultural Europe as well as promote mobility, employment and understanding between nations. Throughout the years, the number of children enrolled in English classes rose significantly in primary schools. Due to this fact, in 2014 DGE stated that, according to article N.º9, line 1 of the Decree-law n.º 176/2014,

> "A disciplina de Inglês inicia-se, obrigatoriamente, no 3.º ano de escolaridade e prolonga-se nos 2.º e 3.º ciclos, num total de sete anos, com o regime de progressão e tr4ansição fixado por despacho normativo do membro do Governo responsável pela área de educação"

Since 2014, English classes have been included in the national curriculum and become compulsory for every child at the age of 7/8 years (which, in Portugal, corresponds to the 3rd grade of primary school). Being the first Foreign Language (FL) that children are exposed to, it is expected that by the time they become adults they will acquire an independent level of proficiency and be better prepared for a steadier, stronger and omnipresent phenomenon of globalisation and multiculturalism. In *Report on Rethinking Education* (2013) the European Parliament argued that learning a Foreign Language in the early years is, in fact, more effective than in later years:

> ...poor language skills constitute a major obstacle to the free movement of workers and to the international competitiveness of enterprises in the Union,(...) language learning is deemed to be much more effective at an early age" (Nevedʼalová, 2013, p. 7)

The contents of FL classes focus on the amount of vocabulary a person acquires as well as on the three most important foundations of a nation: literature, culture and language (CEFR, 2001, p. 56, 135). These areas may improve people's writing, speaking and reading skills as well as listening and, therefore, develop a better fluency and ease when using the language. In order to guarantee a certain level of consistency in Europe regarding the teaching of foreign languages and the proficiency levels, the European Council introduced the Common European

Framework of Reference for languages (CEFR) in 2001 so that it would help Europe reinforce social cohesion, intercultural dialogue, European identity and citizenship, employment and mobility between countries.

In the CEFR, the Council defined six levels of language proficiency: elementary user (A1 and A2), independent user (B1 and B2), advanced and proficient user (C1 and C2). As we can see in Figure 1, the learning outcomes for each level are succinctly described.

Proficient User	C2	Can understand with ease virtually everything heard or read. Can summarise information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation. Can express him/herself spontaneously, very fluently and precisely, differentiating finer shades of meaning even in more complex situations.
	C1	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexibly and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
Independent User	B2	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.
	B1	Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.
Basic User	A2	Can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need.
	A1	Can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type. Can introduce him/herself and others and can ask and answer questions about personal details such as where he/she lives, people he/she knows and things he/she has. Can interact in a simple way provided the other person talks slowly and clearly and is prepared to help.

Figure 1. Levels of proficiency of Foreign Languages (Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR), 2001, p. 24)

As aforementioned, the CEFR emphasizes the importance of facilitating communication and focuses on the learning outcomes the learner must accomplish for each level of proficiency. Therefore, as stated by DGE in Portaria n.º 260-A/2014, at the end-state of compulsory learning,

i.e. high school (Lei n.º 85/2009, Artigo 1.º e 2.º)[2], students are expected to acquire a B2+ level of proficiency in English[3]. For this reason, it is expected that a native Portuguese speaker will be able to interact socially in the FL, i.e. be an independent user, able to interact with others more easily than before, in familiar contexts as well as in non-familiar ones (e.g. the student's presence in a foreign country). According to the Framework, not only do the learning goals focus on linguistic skills, but they also include pragmatic and sociolinguistic competences, the latter being broadly referred to as communicative language competences:

> ***Linguistic competences*** include lexical, phonological, syntactical knowledge and skills and other dimensions of language as a system, independently of the sociolinguistic value of its variations and the pragmatic functions of its realisations. (2001, p. 13)

In this sense, the linguistic competences that an individual must acquire in the FL include the main linguistic domains. Regarding the phonological competence (2001, p. 116), it is subdivided into three areas (Moyer, 2013):

- Phonemes and allophones: the basic unit of speech and their phonetic realizations in different contexts (for example, the same English phoneme, /t/, can have different allophonic realizations depending on the context, [t] and [t^h] as in <steam> and <team>, respectively);
- Syllable structure and the language-specific phonotactics;
- Prosody: stress, segment length, intonation, rhythm, pitch and speech rate;
- In order to successfully perceive and produce the FL speech sounds, the learner has not only to learn how to recognize the contrastive features of the segments but also their allophonic realizations, the language-specific phonotactic constraints, and many suprasegmental features.

Similarly to the objectives stated for each level of proficiency in the CEFR, the learner is expected to achieve specific goals for each level as far as phonological competence is concerned. For example, a person who is enrolled in English classes, acquiring the A2 level does not have the same phonological competence as someone who is studying B2 and is not even expected to

[2] Diário da República, 1.ª série – N.º166 – 27 de agosto de 2009.

[3] Diário da República, 1.ª série – N.º 241 – 15 de dezembro de 2014.

have by the time A2 classes are finished. As the level increases, the objectives become more demanding (see Figure 2).

	PHONOLOGICAL CONTROL
C2	*As C1*
C1	*Can vary intonation and place sentence stress correctly in order to express finer shades of meaning.*
B2	*Has acquired a clear, natural, pronunciation and intonation.*
B1	*Pronunciation is clearly intelligible even if a foreign accent is sometimes evident and occasional mispronunciations occur.*
A2	*Pronunciation is generally clear enough to be understood despite a noticeable foreign accent, but conversational partners will need to ask for repetition from time to time.*
A1	*Pronunciation of a very limited repertoire of learnt words and phrases can be understood with some effort by native speakers used to dealing with speakers of his/her language group.*

Figure 2. Description of phonological skills a learner must accomplish (2001, p. 115)

There is a clear emphasis on the notions of pronunciation, foreign accent, intelligibility, fluency and the presence (thus, comparison) of two phonological systems. These are notions, and occurrences, that may automatically distinguish those who are native speakers of English from the ones who are not and the presence of a foreign accent is one of the most important signs that give away a person's non-native origin. Let us focus on two specific linguistic systems: Portuguese and English. A great majority of children, who were born in Portugal, have the L1 phonological system almost complete at the age of 4/5 years old (Sim-Sim, 1998; Sim-Sim et al., 2008) and two years later, they are enrolled in English classes. In this sense, European Portuguese is their L1 and English becomes their L2[4]. Although these two phonological systems have some differences, they also share some similarities in certain sounds (Azevedo, 1981). For example /f/, /v/ and /ɛ/, people are somehow familiar to certain phonemes which makes the process of the acquisition of these English sounds easier (1981, p. 57). On the other hand, the "new" phonemes, i.e. those sounds which do not exist in the L1 phonological system, are difficult for natives to produce (Escudero, 2005) which may result in a foreign accented speech.

In order to clarify the influence of the L1 phonological system in the process of L2 acquisition, as well as the "new" and "similar" concepts here used, in 1986 Flege carried out a

[4] In this case, L2 is being used with a broader meaning that includes both learning contexts/ environments. Thus, L2 and FL are used interchangeably.

study to investigate "the extent to which L2 learners approximate the phonetic norms of an L2 for "new" and "similar" phones" (Flege, 1987, p. 48). In the study, the author defines "new" phones as the ones which do not have a counterpart in the L1 (e.g. the English /h/ does not exist in the Portuguese phonological system) and "similar" phones are those present in both phonological systems but whose production may vary depending on the context. In this sense, Flege explains that L2 learners categorize L2 phones by the process of equivalence qualification, i.e. L2 phones are classified according to the knowledge of the L1 categories.

> "It is commonly accepted that L2 learners "identify" L2 phones in terms of native language (L1) categories and, as a result, use articulatory patterns established during L1 acquisition to realize those L2 phones" (ibid)

In the study, Flege divided the subjects into six groups of 42 women, who were divided into 6 groups (7 subjects in each group), differing in previous linguistic experience: 14 were Native French (7 monolingual and 7 bilingual subjects) and the remaining 28 were Native English (7 monolingual and 21 bilingual subjects). The groups were tested on the production of specific, similar L2 phones (/u/ and /t/ in both languages) and a new L2 phone (French realization of /y/ for the native English). The results supported Flege and Hillenbrand's hypothesis (1984) that L2 phones are, in fact, compared with and, thus, mapped onto L1 categories but only to a certain extent. L2 learners do assimilate L2 phones to established L1 categories but they are also able to acquire new L2 phones successfully, depending on the quantity and quality of input that a learner is exposed to. The study's results also showed that on the one hand, the new phone is most likely to be produced in its phonetic norm once acquired and, on the other hand, a similar phone may be interchangeably produced either as L1 and L2 categories.

> (...) adults are capable of learning to produce new phones in an L2, and of modifying their previously established patterns of articulation when producing similar L2 phones. It appears that the mechanism of equivalence classification leads them to identify acoustically different phones in L1 and L2 as belonging to the same category. This ultimately may prevent them from producing similar but now new phones authentically. (Flege J. E., 1987, p. 62)

As non-native speakers tend to diverge from the phonetic norms of English, they are easily recognizable by the presence of a foreign accent. It is through the foreign accent that a set of personal characteristics such as our language and social background are transmitted to the others. Moyer (2013, p. 10) explains that accent "provides clues about our age, gender, regional

background, level of education, and even social class". Nonetheless, most people are able to change their speech in different environments in order to be respected and/or claim their status (Giles et al., 1991; 2007).

> "When speaking with others, we continually adjust our pronunciation and alter our prosody in order to clarify meaning, punctuate important points, and signal distance vs. affiliation. In other words, we use accent to position ourselves vis-à-vis others. Thus, accent is a fluid, contextualized expression of our personal and social identity as well as our communicative stance" (2013, p. 10)

Broadly speaking, accent and pronunciation are regarded as equivalent terms but for the present study it is important to clarify the distinctions. Due to its variability, accent is not easily defined but, when contrasting to pronunciation, it represents a dynamic feature of fluency (Moyer, 2013). As noted, accent gives automatic knowledge of our personal, social and educational background but it also refers to the linguistic characteristics that differentiate the semantics and pragmatics of our speech. These include how we produce a set of segments, i.e. the way we articulate sounds, as well as suprasegmental features. In sum, Moyer defines accent as "a set of dynamic segmental and suprasegmental habits that convey linguistic meaning along with social and situational affiliation" (Moyer, 2013, p. 11). On the other hand, according to the author, pronunciation refers to "the place and position of speech organs (tongue, lips, teeth, uvula, larynx, nasal cavity, etc) when producing specific speech sounds" (Ibid, p. 10).

Throughout the years, people tend to judge the other in an automatic way, though unconsciously. How we speak and, most importantly, our accent becomes one of the primary means by which we are judged and not only does it affect our linguistic competence but it also affects how the other regards us. These can include our position towards the other, difficulty to establish a trustworthy relationship and worth, thus our status is compromised.

Native or non-native, the presence of an accent is inevitable; however, a heavy foreign accent may have a negative impact (Lippi-Green, 1997; Derwing & Munro, 2009; Lev-Ari, Shiri, & Keysar, 2010) on how L2 learners are perceived. Several studies were carried out in order to describe some of the effects of this phenomenon (Lambert et al. 1960; Lane, 1963; Giles, 1970; Gumperz, 1982; Fayer and Krasinski 1987; Holden & Hogan 1993) and explain the reasons behind the presence of a foreign accent (Sapon 1952; Penfield, 1965; Lenneberg 1967; McLaughlin 1977; Flege 1992a). Accordingly, a few models have been proposed in order to

explain the main difficulties L2 learners have when acquiring an L2 phonological system. One of the most widely cited theoretical models in L2 speech acquisition is Flege's Speech Learning Model (SLM, 1995) which will be further described in Chapter 1.

Several factors have a strong influence on the L2 learner's ability to acquire/ learn the L2 phonological system and have been studied by L2 speech researchers, including age of onset acquisition (Flege & Fletcher, 1992; Singleton & Lengyel, 1995; Flege et al., 1995b; Bongaerts et al., 1997; Piske, 2001, 2007; Piske, MacKay, & Flege, 2001; Flege & MacKay, 2004), quality and quantity of L2 input (Flege & Liu, 2001; Jia, Strange, Wu, & Collado, 2006), L1 and L2 usage (Flege & Nozawa, 1997; Flege, 1999; Piske, MacKay, & Meador, 2002; Flege, Schirru, & MacKay, 2003), among others. One of the aspects that have been widely investigated in L2 speech research is the link between the age at which people start acquiring/learning an L2 and their phonological competence throughout the years. Generally speaking, studies have demonstrated that the earlier a person starts learning an L2, the more native-like their speech will be. This does not mean that a late learner is not able to acquire such a native-like pronunciation but in most cases a foreign accent may be still detectable in their speech.

> "late" second language learners – those who acquire a language after early childhood – typically show different patterns of L2 perception and production than "early" learners. As a result, "late" second language users are often readily identified because they typically speak with a foreign accent. (Munro & Bohn, 2007, p. 7)

By learning an L2 at an early age, the amount of exposure to the language is higher and the phonetic and phonological properties of the L2 are most likely to be perfectly perceived and produced in later years. As noted by Piske, in Munro & Bohn (2007, p. 302) there are some interesting similarities between learning an L2 in a classroom environment and being an immigrant where the majority/dominant language is the L2. The author claims that "immigrant L2 learners and students in a foreign language classroom may learn an L2 under the same conditions" (ibid) which include AOL (early vs. late learners) and exposure to an L2, as explained next.

Not only FL learners may be exposed to inaccurate pronunciations from their classmates (and teachers) but also L2 learners may spend most of their time with non-native speakers of the L2 and may therefore be exposed to a substantial amount of foreign-accented speech. Similarly, some immigrants may not use the L2 frequently, despite living in the L2-speaking country for

many years; the same occurs with FL learners, depending on the teaching approach in the FL classroom (immersion programs, traditional grammar-translation approach) and the role of explicit instruction, namely the phonetics/phonology of the target language.

As far as differences are concerned, in the same study, Piske mentions that L2 learners learn/acquire the language in a country where the L2 is the predominant language, whereas FL learners learn the language where the L1 is the predominant language, i.e. they are not living in an L2-speaking country. Additionally, there is also the different exposure of input: L2 learners (immigrants) are exposed to a larger quantity of high-quality input (native-like input) and use the L2 more frequently than FL learners.

As the frequent usage of the L2 will certainly help learners to improve their language skills, the recurrent usage of their native language also has an influence on the FL. Flege and colleagues have analyzed the importance of factors that influence the learning of L2 speech and have investigated both subject and phonetic variables affecting bilinguals' production and perception of L2 consonants and vowels (e.g., Flege et al., 1995b; Flege et al., 1997; Piske et al., 2001; Flege, Piske and MacKay, 2002) and their findings reveal that foreign accent also results from the frequent usage of the L1, that is, "ultimate attainment in the pronunciation of an L2 is not only dependent on AOL, but also on language use patterns" (Munro & Bohn, 2007, p. 305). It is advisable, then, to create settings where the L2 learner can use the L2 more frequently, e.g.: adult L2 learners who enrol in English classes should speak in English throughout the class and make an effort to use it as much as possible in other English-speaking environments. According to a few studies, formal instruction may also have an effect in L2 speech learning. For example, Flege and his colleagues carried out studies on the effect of EFL formal instruction on foreign accent (Flege et al., 1995, Flege et al., 1999) and the results showed that formal instruction helps learners improve L2 pronunciation accuracy, particularly if it includes phonetic training (Piske T. , 2007).

Moreover, Piske (2007) adds that "students in a foreign language classroom should particularly benefit from learning environments in which they receive a substantial amount of high-quality input over a period of many years" and for this reason, it is important to study the effects of formal instruction on L2 learners' phonological development. On the one hand, children are exposed to the L2 from an early age, benefiting from several years of formal instruction in which the use of the L2 is expected to be more frequent and the accent more native-like. On the

other hand, adults who do not spend as much time in the L2 classroom as children do are most likely to use the L2 in classes as well as in the workplace, but not at home.

As far immigrants are concerned, the amount of high quality and quantity exposure they receive can improve the learner's phonological competences in the L2. Moreover, when immersed in a classroom environment and subjected to start learning an L2 at an early age, it is most likely that these L2 learners will be proficient learners. In order to investigate this, Flege and Liu (2001) conducted a study to test if there was a connection between AOL and formal instruction and their results supported the idea that formal instruction has an important role when acquiring an L2 phonological system and this is most seen in early bilinguals rather than late bilinguals as they are immersed in L2 environments from childhood. Therefore, the study of L2 acquisition not only involves the study of language itself (e.g. grammar) but also other fields such as education and psychology (Munro & Bohn, 2007).

Research has focused on the challenges that L2 learners face due to processes of interference and transference between the L1 and L2 phonological systems of learners and for this reason, Munro and Bohn defend that "the objects of study in L2 speech research must include not only speech sounds, but L2 learners themselves" (2007, p. 4) ESL has been the main topic of research and various studies have proven to be of great help to the understanding of speech production and perception of non-native speakers of English (Bohn and Flege, 1990; Flege, Munro and Fox, 1994; Flege, MacKay, and Meador, 1999; Rato, 2013).

Regarding native Portuguese learners of English as a Foreign Language (EFL), one of the most difficult phonemes to produce is the voiceless glottal fricative /h/ (Osborne, 2015). As abovementioned, the feature "aspiration" does not exist in the Portuguese phonological system (Azevedo, 1981, p. 72) which normally results in two common errors for the native speakers of Romance languages: the omission of the sound in English words such as <house> and <holidays> and/or the insertion of /h/ where it does not exist (e.g.: */ [h]*ate apples*) (John & Cardoso, 2007). Thus, the speaker is easily recognized by his/her foreign accent and in this particular case, communication may be broken due to the misproduction of the English phoneme and his/her speech intelligibility may be compromised. Even though there have not been many studies investigating the learning of this non-native by L2 learners, Gonzalo-Llera (2011) and John and Cardoso (2007) showed that this difference in pronunciation also occurs in other Romance languages such as Spanish and French, respectively.

The present study aims at investigating the production and perception of this "new" phonetic category as far as native Portuguese speakers of English are concerned. In the light of James Emil Flege's Speech Learning Model, the specific objectives of this research are the following: 1) examine whether Portuguese EFL advanced learners are able to perceive accurately a "new" L2 phonetic category; 2) investigate whether these learners produce the English phoneme /h/ correctly, namely in word initial and medial positions; 3) analyse if there exists an effect of elicitation technique (word reading vs. picture story description) on the production of the target phoneme; 4) study these FL learners' ability to discriminate and identify the target phoneme accurately and 5) verify if there is a link between the production and perception abilities of Portuguese learners in the acquisition/learning of the target phoneme.

According to Piske, Mackay and Flege (2001), and Piske (2007) the factors that most affect L2 pronunciation are AOL (Age of learning) and L2 use. Other factors, such as L1 background, and quantity and quality of L2 input are also strong predictors of a foreign accent. Following the research carried out by John and Cardoso (2007), the authors state that the insertion of /h/ occurs mostly "in stressed syllables, with a preceding pause or vowel, with /h/ in proximity, and in more formal speech" (2007, p. 265) and /h/ omission happens as a consequence of the non-representation of the phoneme to an L1 category. As far as perception is concerned, learners are expected to notice the realization of the sound, having little difficulty in discriminating (i.e. distinguishing) as well as identifying (i.e. labelling) it. Nonetheless, it is predicted that the participants of the experiment will have more difficulty in producing the /h/ sound than perceiving it, as the Portuguese language has its representation orthographically but no phonological representation.

The present dissertation is structured in the following way:

Chapter 1 briefly describes the mechanisms of speech production and perception, as well as the interface between the two linguistic domains of speech acquisition, and explains the processes of transference and interference between the L1 and the L2. In addition, the first chapter of the dissertation also includes an articulatory description of the English glottal fricative (/h/), and a summary of the mains patterns of misproduction of the target sound.

The method of the experimental study is described in Chapter 2. This section includes the research questions and hypotheses, information about the participants, the production and perception tasks and the procedures of data collection and analysis.

Chapter 3 presents the results of the data analysis in three sections. Firstly, the production results, secondly, the perception data and, thirdly, the comparison between the production and perception data. Finally, it provides a discussion of the findings in light of the theoretical models of L2 speech acquisition.

CHAPTER 1

THEORETICAL FRAMEWORK

This chapter is concerned with the theoretical context related to the topic of the dissertation. Firstly, an explanation of the mechanisms related to speech acquisition will be given in order to familiarize and contextualize the reader with linguistic notions present throughout the study. These include descriptions of the production and perception mechanisms as well as the interface between these two speech domains. Nevertheless, we will focus on the two phonological systems this study is concerned with (English and Portuguese), giving a special attention to the processes of transference and interference between L1 and L2. Furthermore, a brief articulatory description of the phoneme /h/ is introduced followed by its realization as far as non-native speakers of English are concerned.

1.1 Second Language Speech Acquisition

Over the past few decades, second language acquisition has been one of the most studied themes in Linguistics, more specifically in the branch of Phonetics and Phonology. As bilingualism is becoming a worldwide phenomenon, the need to understand processes and mechanisms behind the acquisition of an L2 are receiving a lot of attention, especially when it comes to the way listeners receive the message and the way a message is conveyed. Flege defines speech learning as the process by which L2 learners come to "articulate or perceive a speech sound differently after (as compared to before) massive exposure to a foreign language" (Munro & Bohn, 2007, p. 3). In other words, speech learning focuses on how a second language learner comes to produce or perceive, i.e. distinguish, the sounds of the L2 after he or she is exposed to the L2. By being in direct contact with the language, the learner will be able to better perceive and produce the L2 sounds.

The cognitive processes involved in acquiring a second language will automatically lead the EFL student to create a comparison between the two phonological systems. On the one hand, sounds which are acoustically similar to the L1 will be not as difficult to produce as what Flege defines as new sounds, i.e. sounds that differ acoustically from L1 categories. Though unconsciously, the FL student will engage in processes of transference and interference between

the two languages, which can either help or stop learners from producing the L2's phonetic norms.

1.1.1 Speech Production

Speech production, or articulatory phonetics, is the study of how a speaker articulates the vocal tract's structures in order to produce consonants and vowels of a language. This particular process is divided into three main phases: *conceptualization*, *formulation* and *articulation* (Levelt, 1989; Levelt, Roelofs, & Meyer, 1999). In the first phase, the speaker determines the message he/she is trying to convey, *formulation* involves the process of translating this abstract thought into a linguistic form while, last but not least, *articulation* refers to the anatomic processes that transform the conceptual representation into sounds. From the three cognitive processes mentioned, the third one (articulation) is the most important for the current part of the dissertation.

The study of articulatory phonetics explains how humans produce speech sounds by the transformation of air-flowing energy into acoustic energy. Figure 3 shows the mechanism of speech chain which is divided in three phases.

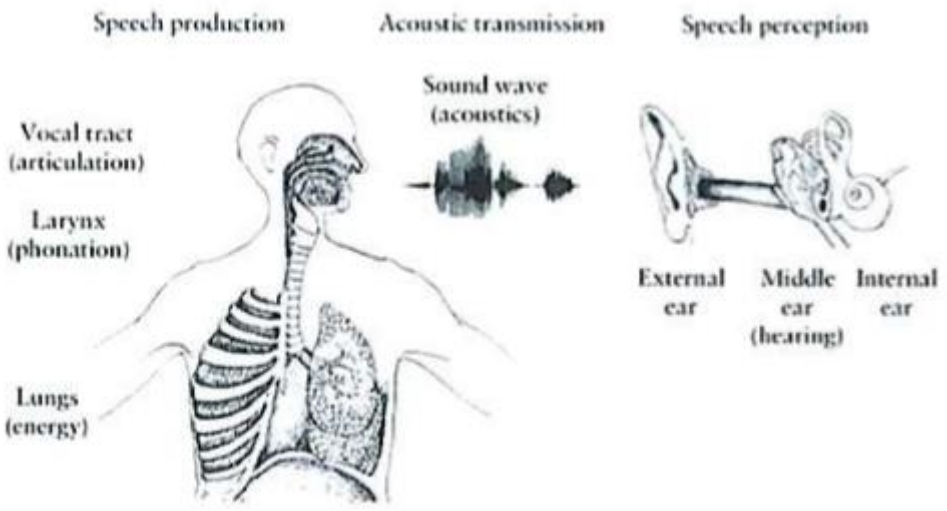


Figure 3. The speech chain (Reetz & Jongman, 2009, p. 2)

The first phase, speech production, shows that three physiological structures interact with each other in order to produce the sounds of a language. The lungs are the main source of energy that is needed so that phonation can occur in the larynx, which will then be articulated in the vocal tract.

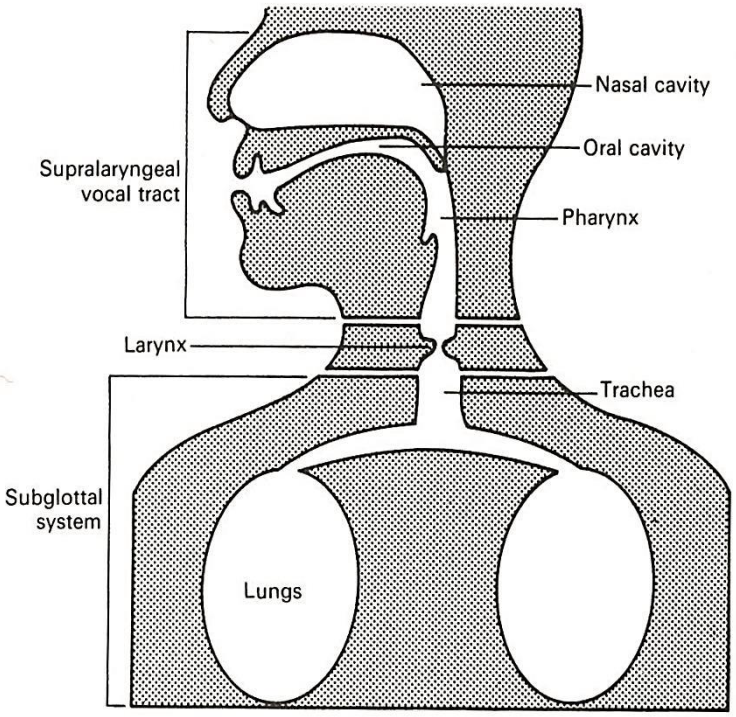


Figure 4. The three physiological components in the process of speech perception (Liberman & Blumstein, 1998, p. 4)

In the lungs, the manner of the airstream mechanisms can be divided into two: egressive (air being pushed out) and ingressive (air being pushed in). Nevertheless, these manners can occur in three anatomic components of the speech chain: the lungs (pulmonic), when the glottis is closed (glottalic) and when the velum is closed (velaric). As far as English is concerned, a great majority of its sounds are produced by a pulmonic egressive airstream mechanism. In this sense, as far as speech production is concerned, the sounds of a language can be explained according to the manner of the airstream (either egressive or ingressive) and the initiator (pulmonic, glottalic and velaric).

Regarding speech production, the main role of the larynx is "to convert a relatively steady flow of air out from the lungs into a series of almost periodic, i.e. 'quasi-periodic,' puffs of air" (Liberman & Blumstein, 1998, p. 4). This transformation occurs at the glottis, either open or

closed, by the movement of the vocal cords inwards or outwards, producing a source of acoustic energy. In this sense, the vocal cords play an important role in determining whether a sound is voiced or voiceless, i.e. when vibration occurs or not when producing certain phonemes. If the vocal cords are close together, the airflow is obstructed causing vibration and voiced sounds occur. On the other hand, when the vocal folds are apart, the airstream coming out from the lungs passes freely though the larynx and voiceless sounds are produced.

When the energy reaches the supraglottal system (the vocal tract), the sounds are modified and articulated in order to produce the target phoneme. The vocal tract can be divided into three components that function as tunnels where the airflow can pass and be articulated: the nose (nasal cavity), the mouth (oral cavity) and the pharynx. In this sense, the supralaryngeal vocal tract functions as a variable acoustic filter since the speaker modifies the shape of this system in order to produce speech. Hence, phonemes are described according to their manner and place of articulation which are the distinctive features that enable listeners to distinguish one sound from the other, as explained next.

Speech sounds are divided into two major classes: consonants (often abbreviated as C) and vowels (abbreviated as V). For the present study, we shall focus on the place and manner of articulation as far as consonants are concerned. As the vocal tract is the place where sounds are modified and shaped, its organs are responsible for the articulation of phonemes and thus they are called *articulators* which can be either active or passive. The articulators that move are called the active articulators (e.g.: tongue, velum and larynx) while the articulators which are fixed, i.e. those that do not move, are termed as passive articulators (e.g. teeth, alveolar ridge and the velum). Nevertheless, it is important to remark that certain articulators can be either passive or active (an example is the lips where the upper lip functions usually as the passive articulator while the lowers lip is normally the active articulator).

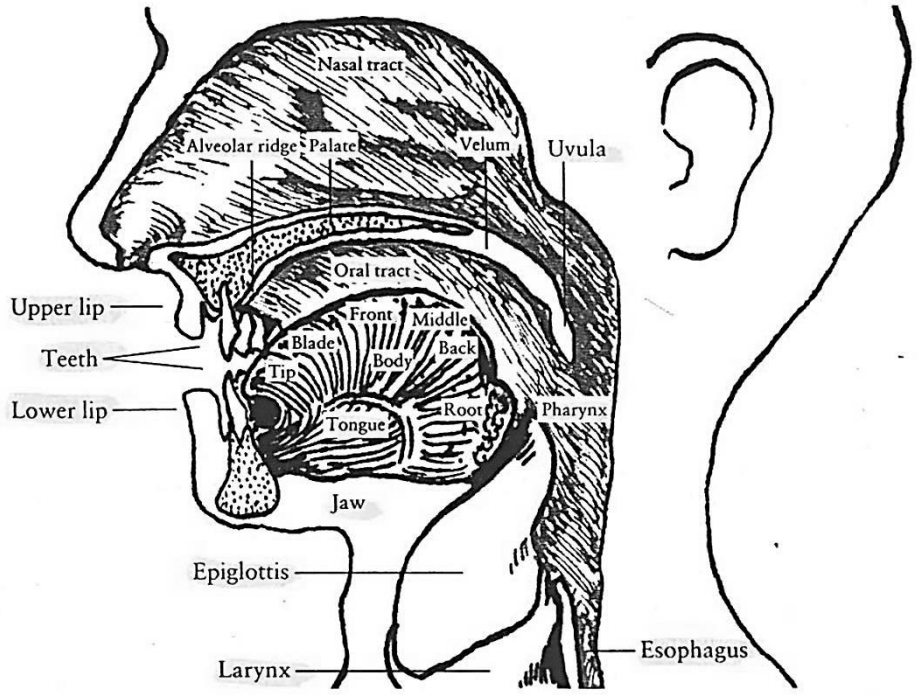


Figure 5. The vocal tract (Reetz & Jongman, 2009, p. 10)

Let us focus now on the different ways the vocal tract is shaped in order to produce speech and describe English consonants (Reetz & Jongman, 2009):

1. Bilabial sounds are produced by the touch of the upper and lower lip as is the case in the beginning of words such as <**m**ouse>, <**b**icycle> and <**p**ure>;
2. Labiodental consonants are those where the lower lip moves in order to touch the upper front teeth (e.g.: <**f**antastic> and <**v**ulnerable>);
3. Dental: the initial sound in <**th**ose> and <**th**ought> is produced when either the tip or blade of the tongue makes contact with the upper front teeth;
4. Alveolar sounds are shaped when either the tip or blade of the tongue touches the alveolar ridge, producing the initial sound in words such as <**t**op>, <**n**ote> and <**z**apping>;
5. Retroflex is a sound that occurs when the tip of the tongue is raised towards the back of the alveolar ridge (e.g.: <**r**ight>);

6. Examples of postalveolar consonants include <**sh**ine>, <**ch**ocolate> and <**j**uice>. They are articulated by the movement of the tip or blade of the tongue towards the back of the alveolar ridge;
7. Palatal: the front of the tongue and the hard palate come together as in <**y**outh>;
8. Velar sounds are produced when the back of the tongue makes contact with the velum (e.g.: <**c**ostume>, <**g**reat> and <lo**ng**>;
9. When the vocal folds are separated and the glottis open, a glottal sound is articulated and the English /h/ is the only one that possesses this distinctive feature (e.g.: <**h**oroscope>).

Nevertheless, if one wishes to describe the complete features of speech sounds, one should also refer to the obstruction of the vocal tract, i.e. the manner of articulation. These distinguishable features occurring in the vocal tract are the following (Ibid):

1. Stops (also known as plosives) are sounds in which the articulators come together so that the airstream is blocked or constrained. When the velum is raised, both nasal and oral cavities are closed. Nevertheless, due to the pressure in the mouth, the air is forced to explode in a small outburst as in the initial sound of the following words: <**b**rilliant>, <**t**angle> and <**k**itchen>;
2. Nasal sounds occur when the air tries to escape through the oral cavity but since the velum is lowered, the cavity is obstructed. Thus the airflow is forced to pass through the nasal cavity and nasal sounds are produced (e.g.: <**m**ust>, <**n**ight> and <so**ng**>;
3. Fricatives are produced when the air is forced to go through a narrow passage which is created when two articulators come close together. Even though there is no complete obstruction, the pulmonic air is forced through the passage, leading to the production of hissing sounds (e.g.: <**f**ight>, <**th**orough> and <i**c**e>);
4. Affricate sounds are produced when a stop is immediately followed by a fricative, as it happens in <**ch**an**g**e> and <knowle**dg**e>;
5. Approximants: because its characteristics include those present in consonants and vowels, approximants can also be referred to as semi-

vowels. Due to the fact that the air flow is slightly obstructed, approximants occur when one articulator approaches the other but not close enough to cause friction (e.g.: <**w**ine> and <**y**oung>). In these two examples, the airflow escapes through the middle section of the oral cavity and this is why they are called central approximants. On the other hand, in the initial sound in <**l**ight>, the air passes freely through the sides of the oral cavity (lateral approximants).

In sum, the production of English consonants can be distinguished according to their phonation (voiced and voiceless sounds), place of articulation (bilabial, labiodental, dental, alveolar, postalveolar, palatal, velar and glottal) and manner of articulation (stops, nasal, affricate, fricative, lateral approximant and approximant). Figure 6 summarizes the place and manner of articulation of English consonants.

English consonants:

	[+anterior]				[-anterior]					
	labial		dento-alveolar		alveo-palatal		velar		glottal	
Noncontinuant	p	b	t	d	č	ǰ	k	g		
Fricative										
-strident	f	v	θ	ð					h	
+strident			s	z	š	ž				
Lateral				l						
Nasal		m		n				n		
Glide		w		r	y					

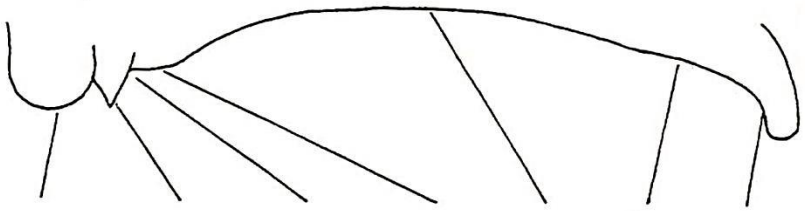
Figure 6. Place and manner of articulation of English consonants (Azevedo, 1981, p. 72)

As aforementioned, native Portuguese who are speakers of English find certain sounds difficult to produce at first (e.g.: /h/ is often not produced by native Portuguese). Conversely, there are other phonemes present in both phonological systems as is the case of /s/ and /k/. For this reason, it is important to compare the English phonological system to the European Portuguese (EP) one.

The European Portuguese phonological system consists of 24 phonemes for consonants. Most of these phonemes are also present in English but its production can depend on context as

well as the size of an individual's vocal tract. The following table presents the place and manner of articulation of consonants in the European Portuguese system.

PONTOS DE ARTICULAÇÃO



MODOS de ARTICULAÇÃO		Bilabiais	Labiodentais	Alveodentais	Alveolares	Palatais	Velares	Uvulares
Oclusivos	Orais Surdos	[p]		[t]			[k]	
	Orais Sonoros	[b]		[d]			[g]	
	Nasais Sonoros	[m]		[n]		[ɲ]		
Constritivos	Fricativos Surdos		[f]		[s]	[ʃ]		
	Sonoros	[β]	[v]	[ð]	[z]	[ʒ]	[ɣ]	
	Laterais Sonoros				[l]	[ʎ]	[ɬ]	
	Vibrantes Sonoros				[ɾ] [r]			[ʀ]

Figure 7. Place and Manner of articulation of European Portuguese Consonants (Barroso, 1999, p. 104)

However, there are some phonemes which do not occur in one of the languages (see Figure 8). For example, the English dental fricative /θ/ and glottal fricative /h/ are not present in figure 7 which means that these two sounds will be regarded as non-native for Portuguese people. In this sense, as far as production is concerned, it is expected that speakers who have EP as their L1 and English as their L2 will have more difficulty in articulating the non-native sounds as they do not know how to articulate them. The following figure provides information on what sounds are present in both languages as well as the ones that only occur in English.

Portuguese consonants:

	[+anterior]				[-anterior]				
	labial		dento-alveolar		alveo-palatal		velar		
Noncontinuant	p	b	t	d			k	g	
Fricative	f	v	s	z	š	ž	(x)		
Lateral				l		l			
Nasal		m		n		ñ			
Vibrant			ɾ	r̄					

English consonants:

	[+anterior]				[-anterior]				
	labial		dento-alveolar		alveo-palatal		velar		glottal
Noncontinuant	p	b	t	d	č	ǰ	k	g	
Fricative									
-strident	f	v	θ	ð					h
+strident			s	z	š	ž			
Lateral				l					
Nasal		m		n				n	
Glide		w		r	y				

Figure 8. Place and Manner of articulation of English and Portuguese consonants (Azevedo, 1981, p. 72)

A native Portuguese is expected to have little difficulty in producing sounds which are present in both phonological. For example, NPSs (native Portuguese speakers) are not expected to have difficulties in producing the English /p/ due to the fact that they have already acquired the articulatory knowledge to produce that sound in their L1. On the other hand, sounds not found in the L1 inventory (e.g.: the English fricatives /ɵ/ and /ð/) are expected to be phonetically realized with a certain difficulty since NPSs lack the knowledge on how to shape their vocal tract in order to realize those sounds.

Having covered the main processes on L1 and L2 speech production, the following section focuses on speech perception and the processes as well as mechanisms behind this speech domain.

1.1.2 Speech perception

Speech perception, or auditory phonetics, tries to explain how listeners make sense of the sounds they hear, how they discriminate and identify the phonemes present in the phonological system of a language in order to understand what is being said. In order to do so, the sounds being articulated by the speaker are transformed into acoustic signals (sound waves) followed by the conversion of these signals into a set of discrete units by the hearer (Reetz & Jongman, 2009). As these articulatory gestures are then transformed into acoustic patterns, pragmatics, semantics and syntax are some of the linguistic fields of study that can affect how a message is perceived. At the acoustic level, speech signals are continuous but as far as perception is concerned, they are composed by "individual phonemic segments, that is, vowels and consonants" (Rato, 2013). As Reetz and Jongman explain, "the speech signal can rarely be segmented in a way that corresponds to perceived individual phonetic units" (Reetz & Jongman, 2009, p. 251), thus the acoustic signals are characterized by their non-linearity with human perception.

Researchers have developed several topics in order to explain how hearers interpret acoustic signals as speech sounds. Some examples include *The Motor Theory of Speech Perception* and *Categorical Perception*.

The Motor Theory of Speech (1985) defends that speech is perceived when the listener observes the speech sounds being articulated by the speaker.

> The objects of speech perception are the intended phonetic gestures of the speaker, represented in the brain as invariant motor commands that call for movements of the articulators through certain linguistically significant configurations. (Liberman & Mattingly, 1985, p. 2)

The authors state a difference between "the gestural events" and the "attributes of the gestural events". The former are concerned with the physical authenticity of each sound while the latter involve the features we attribute to it (e.g.: [n] is the physical reality of the sound while nasal alveolar are its distinctive features). As the processes behind the production of speech are influenced by gestures represented in the speaker's brain, its perception is then influenced by the movement of the articulators. These acoustic signals are automatically converted into a phonetic gesture and it is the latter that the listener perceives.

Following this perspective, the authors reach the conclusion that speech production and perception are directly linked since "perception of the gestures occurs in a specialized mode (...) responsible also for the production of phonetic structures" (Ibid, 3). Furthermore, this link "is innately specified" and systematic "because it results from lawful dependencies among gestures, articulator movements, vocal-tract shapes and signals" (Ibid, 6). These are the main statements provided by the Motor Theory, which will be explained in more detail next. Firstly, we will focus on the object of speech perception followed by a description of the link between the speech domains and their interrelation.

The Motor Theory states that "phonetic perception is perception of gesture" (Ibid, 21) which is "based on evidence that the invariant source of the phonetic percept is somewhere in the processes by which the sounds of speech are produced" (Ibidem). In other words, the production of any speech sound is based on its distinctive and fixed properties, automatically configured in the vocal tract. For example, in order to produce the first sound in <mouse>, a labial sound is produced which is characterized by the upper and lower lips touching each other and the airflow escaping through the nasal cavity. In sum, as far as the Motor Theory is concerned, these invariant properties are the objects of speech perception which "correspond to the speaker's intentions" (Ibid, 23).

Given the connection between gestures and acoustic signals, an interrelation between speech production and perception becomes obvious. As aforementioned, production and perception share an inherent link, meaning that every human is able to perceive speech as well as to produce it. Even though infants do not ascribe any linguistic meaning to what they hear, they are able to perceive sounds (Best, McRoberts, & Sithole, 1987; Eimas et al., 1971; Eimas, 1974). Furthermore, the authors explain that every human perceives phonetic gestures but the recognition and categorization of significantly phonetic gestures is different in infants and adults.

> Perception of the phonetic categories can properly be generalized only if the acoustic patterns are taken for what they really are: information about the underlying gestures. No matter that the child sometimes mistakes the phonological significance of the gesture, so long as that which he perceives captures the systematic nature of its relation to the sound; the phonology will come in due course. (Liberman & Mattingly, 1985, p. 25)

This interrelation between production and perception is special because it only occurs in speech. In addition, it is characterized as systematic "by virtue of a model of the vocal tract that embodies the relation between gestural properties and acoustic information" (Ibid, 29). The perception of these gestures occurs in a specialized mode, as abovementioned, which is also responsible for the production of speech. Following this idea, the authors explain that speech perception occurs in a specific part of the brain, the "specialized neural architecture", responsible for the performance of certain computations that will "provide central cognitive processes with representations of the objects or events belonging to a natural class that is ecologically significant for the organism" (Ibid, 27). In other words, the notion of specialized mode refers to the fact that speech perception is a specific linguistic domain that takes place in a certain part of the brain where the phonetic gestures are represented, enabling the listener to understand the information provided by the articulation of those gestures.

In sum, the Motor Theory provided and revised by Liberman and Mattingly (1985), states that the object of study for speech perception is to be found in the phonetic gestures the speaker articulates. Nevertheless, the listener is able to perceive those phonetic gestures rather than the acoustic signals, meaning that speech perception and speech production are intertwined and one cannot occur without the other. This link is innate, meaning that all humans are able to perceive speech due to the fact that it occurs in a specialized neural architecture. In this sense, the neuromotor commands found in this area are responsible for the representation of the phonetic gestures, thus the listener is able to perceive speech.

The second theory, Categorical Perception, holds that stimuli are organized in categories rather than in labels. The hypothesis states that "stimuli, equally spaced along some physical continuum, are perceived as belonging to one or another perceptual category instead of varying as a function of their physical values" (Reetz & Jongman, 2009, p. 265). In the same book, Reetz and Jongman describe an experiment that focused on the identification and discrimination of two categories (/dɑ/ and /tɑ/) in order to test this theory. The stimuli were presented in a random manner and the results showed that the variation from one category to the other was "abrupt or categorical" (Ibid: 266) in the identification test. As the author had predicted, when "the two stimuli are difficult to distinguish, listeners will identify a given stimulus X half the time as A and half the time as B" (Ibid: 267) which the discrimination test proved. Given the results, the author concludes that, after all, "discrimination is indeed no better than identification" (ibid: 268). In

sum, the Categorical Perception theory claims that listeners perceive sounds when members of the same category rather than discrete units.

As far as SLA is concerned, several factors do have an influence on how learners perceive and then produce L2 sounds. These include age of learning, the amount of exposure as well as quality input that the learner receives. Such factors prove that every human is able to adapt to different language contexts and the more he/she is exposed to an L2, the greater his/her perception of L2 speech will be. Furthermore, some researchers argue that "the way in which listeners divide a continuum is determined by language-specific experience" (Reetz & Jongman, 2009, p. 275). However, in response to this experience, the L2 learner is expected to reorganize and adapt the cognitive structures responsible for the perception of L2 phonetic norms instead of L1. Thus, as Reetz and Jongman explain, "there is a high degree of plasticity in the perceptual system" (Ibidem) present both in adults and children. The notion of plasticity is linked to the Critical Period Hypothesis (1967) which we will explain in the following sub-chapters along with other theories.

1.1.3 Interface between production and perception

As aforesaid, speech production and perception share a direct link when it comes to the acquisition of any language. However, the nature of this link remains unclear. Some critics believe that the presence of a foreign accent is due to the inability to produce L2 sounds correctly, after a period has passed (Lenneberg, 1967) while others explain that incorrect perception of the L2 sounds leads to stronger foreign accents (Rochet, 1995)

Throughout the years, some studies have claimed that people are able to speak a language with undetectable foreign accent if and only if that same language is learned before puberty (Lenneberg, 1967). By extending this process to SLA (Johnson & Newport, 1989) the Critical Period Hypothesis (CPH) states that people are able to produce the phonetic norms of a language within a limit of age, from childhood until adolescence/ puberty (12 years old). After that time, as humans mature neurologically the ability to learn a language diminishes and, as a consequence, new phonetic norms cannot be learned perfectly. This means that as humans go through processes of neural maturation the notion of neural plasticity diminishes and, as an effect, so does the neural part responsible for articulatory representations. Thus, as far as this

model is concerned, it is expected that late learners (i.e., learners who are older than 12 years old) speak an L2 with a stronger foreign accent than early learners (i.e. learners who are 12 years old or younger). Even though the CPH model is consistent with the fact that the earlier someone acquires an L2, the more native-like their speech is (thus, the less noticeable their foreign accent will be) it does not explain the fact that there are some early L2 learners who speak English with a detectable foreign accent (Flege et al.,1995; 1999).

By applying the Critical Period Hypothesis on second language learners, Flege and his colleagues carried out some experiments in order to prove if there is, in fact, an age-related limit as far as L2 accent is concerned. In 1999, Flege and Liu conducted a study in order to examine the degree of foreign accent in Native Koreans who have English as their L2. These participants were immigrants in the United States who reached American soil between the ages of 2 to 23. Along with AOA (Age of arrival), the authors also took into consideration the usage of L1 and L2 by the participants as well as the amount of exposure to those same languages. The study focused on the production of English sentences by native Koreans being evaluated by Native English, as far as foreign accent is concerned, and the results showed that there is in fact a relation between AOA (or AOL as far as the significant amount of exposure is concerned) and foreign accent. In general terms, the results this study provides do show that AOL, along with language usage, influences the presence of a foreign accent, as we can see in Figure 9.

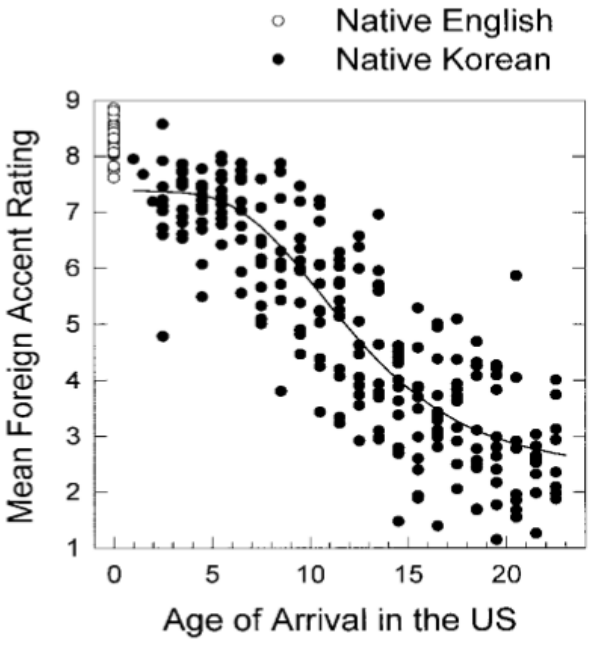


Figure 9. Mean Foreign Accent obtained from Native English and Native Korean (Flege, Yeni-Komshian, & Liu, 1999, p. 85)

However, the study also proved that not every single early learner is able to speak an L2 with undetectable foreign accent. As we can see in figure 6 there are also adult or late learners of English who were able to speak the L2 with foreign accent but not as strong as expected. Moreover, we can also see that there are early learners who do speak English with detectable foreign accent, contrarily to what the Critical Period Hypothesis states. Therefore, we can conclude that the presence of a foreign accent occurs not only in late learners, i.e. after a critical period has passed, but also in early learners. From this point of view, accented pronunciations are not to be completely explained by the inability to produce the phonetic norms of an L2 after puberty.

Even though production has been the main focus of L2 studies of foreign accent, some researchers argue that perception plays an important role as far as accent is concerned (Rochet, 1995). Generally speaking, the amount of exposure to an L2 functions as a positive influence on the production of L2 sounds as well as its perception (Flege & Liu, 2001; MacKay, Piske, Flege & Schirru, 2001). One important example that proves the crucial role of perception is related to the fact that L2 learners face some difficulties when producing L2 sounds that are not present in their L1's phonological system. By processes of assimilation, L2 leaners tend to categorize L2 sounds to the most similar one found in the L1, leading to perceptive errors which often result in the misproduction of certain phonemes. As Rochet points out, "L2 phones that are not part of L2 learners' L1 inventories are usually perceived as belonging to some L1 category" (1995, p. 392). In this sense, as far as Rochet is concerned, the ultimate attainment in L2 speech is to be analysed and observed by an orderly function between production and perception, i.e. improvements in perception will lead to improvements in production.

In order to understand the nature of the link between these two speech domains, Sheldon and Strange examined the relationship between production and perception. In their study (1982), the authors focused on the perception of the English /r/ and /l/ by Native Japanese who were learning English at the time they were tested. The results showed that participants found the phonemes more difficult to perceive rather than to produce. As the participants were enrolled in English classes, it is normal that their production was more accurate since their English education might teach them the articulatory norms to produce the sounds of the L2 (Flege, 1991). For this reason, Sheldon and Strange proved that perceptual difficulties may occur even if after production skills are acquired.

When it comes to the perception of non-native phonemes, L2 learners have more difficulty in producing them and thus linguistic experience improves the perception of non-native L2 phonemes. Thus, some authors explain that "training appears to be necessary for listeners to learn how to perceive many non-native phonetic categories" (Logan & Pruit, 1995) as L2 learners are significantly exposed to the language. Moreover, non-native speech results from processes of transference and interference between the two phonological systems. L2 learners tend to categorize and classify L2 categories according to the phonological system of L1, a process commonly known as *equivalence classification*. The following section deals with this process by focusing on the mechanisms of transference and interference between two phonological systems.

1.1.4 Transference and interference

In order to account for the difficulties L2 learners have in perceiving non-native phonemes, Logan and Pruitt (1995) focus on perceptual training and its methodological issues. It is expected that learners are unable to classify certain L2 phonemes to L1 categories as they are not present in the phonological system of their mother tongue. However, the authors explain that the main goal of perceptual training is "to facilitate the long-term development of a novel phonemic category that is potentially usable among a variety of phonetic contexts, talkers, and other sources of variability" (Logan & Pruit, 1995, p. 353)

The success of perceptual learning then underlies a process of generalization, i.e. "the transfer to other settings of what is learned during training" (Ibid). Hence, generalization, or training transference, can be described as the listener's ability to improve his/her production skills as far as perception is concerned. Consequently, if perceptual training is based on tasks that present listeners with diverse sources such as stimuli variability (i.e. randomized and spoken by different and new talkers), in different phonemic contexts and environments, it is expected that the listener will improve his or her perception skills and transfer this to the production of L2 sounds. Furthermore, L2 learners are then able to identify and categorize the novel phoneme for a long period of time.

> ...the perceptual categories in speech must be adaptive, dynamic, and extremely flexible in order to accommodate the changing stimulus environment that is one of the most distinctive characteristics of speech perception and production. (Pisoni & Lively, 1995, p. 455)

To conclude, some studies (Logan et. al, 1991; Lively, Logan & Pisoni, 1993, Rochet, 1995) proved to be of useful insight as far as perceptual training is concerned. That is, perceptual performance is transferred into production and that training helps learners to perceive and produce non-native phonemes. Consequently, phonetical categories can be modified even in adult learners since our perceptual system "exhibits considerable plasticity" (Reetz & Jongman, 2009, p. 278)

In order to propose an alternative model to the Critical Period Hypothesis and one that accounts for processes of transfer and interference, Flege (1981) assumes that "neither physiological maturation nor neurological reorganization renders an adult incapable of speaking a foreign language without accent" (Flege, 1981, p. 445). Furthermore, the author believes that the presence of a foreign accent occurs as a result from the process of what would be termed as *equivalence classification*.

> ...a tendency by mature speakers to interpret sounds occurring in a foreign language in terms of sounds found in their native language may be a more important cause of foreign accent rather than any limitation on phonetic learning imposed by neurophysiological maturation. (1981, p. 449)

The comparisons between an L1 and L2 phonological systems are obvious when acquiring an L2 and it's important to notice that its effects on the learner can be both positive and negative. Similarly to the term *equivalence classification*, Contrastive Analysis (CA) explains that L2 learners tend to categorize L2 phonemes according to similar phonemes present in their native language. As a result, those similar phonemic categories are easily identifiable and produced. Nonetheless, the L2 categories not present in the L1's phonological system will be unrecognizable, thus not produced at all or produced as far as orthographic interference is concerned (Bassetti, 2008).

In order to examine the effect of *equivalence classification* on L2 learners, Flege (1987) conducted an experiment where he studied how these learners categorize "new" sounds, i.e. non-native phonemes, and "similar" sounds. In this sense, the author defines *new* sounds as the ones that do not have any counterpart in the L1, i.e. those that are acoustically different from sounds in the L1. On the other hand, he defines *similar* sounds as the ones that occur in the native language which are not only equal but also acoustically similar, for example Portuguese /t/ and English /t^h/ (1987, p. 48). On the difficulty to perceive non-native phonemes, the author

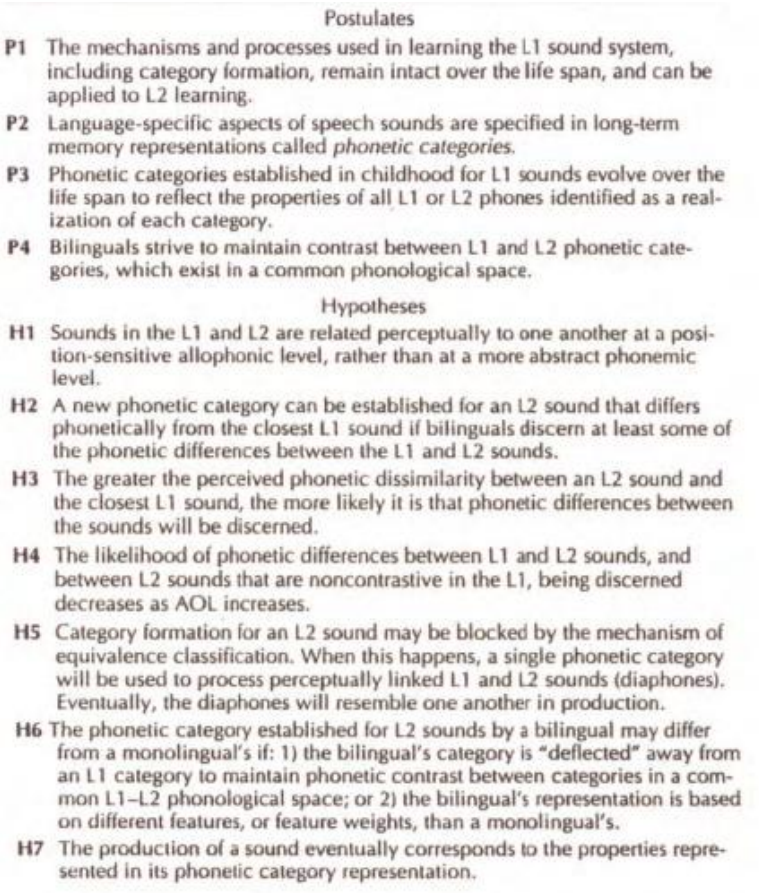
assumes that the reason is based on the hypothesis provided by Trubetzkoy (1969). His hypothesis explains that once the L1 phonological system is fully acquired, L2 learners tend to discard the acoustic differences not applicable in the L1. Following this line of thought, participants are expected to have more difficulty in perceiving and producing new sounds rather than similar ones. Furthermore, the process of equivalence classification only relates to the fact that similar phones are successfully acquired rather than non-native ones. However, in previous studies (1981, 1984), Flege and his colleagues proved that there exists a limit "on the extent to which L2 learners approximate L2 phonetic norms for similar phones" (1987, p. 51).

A group of 42 women participated in the study. They differed in their native language (English and French), their second language (French and English, respectively) and the amount of time spent in a given L2 speaking country. The results showed that, in fact, there exists a limit to which these learners estimate L2 phonemes to similar L1 ones but not as far as *new* sounds are concerned. The data provided from the study showed that even highly experienced L2 learners are more likely to produce similar phonemes according to their L1's phonetic norms. Furthermore, as far as stop consonant production is concerned, L2 learners tended to produce similar sounds according to the L1's phonological system, proving that L1 does interfere with L2.

Regarding new sounds, the study showed that when native English produced the French /y/ (a sound that differs acoustically), there was little difference in the VOT (Voice onset time) between these participants and the native French. This suggests that since there is no term of comparison, L2 learners are able to perceive new sounds as far as L2 phonetic norms are concerned. For this reason, as they are able to perceive it, they are also able to produce non-native sounds (Ladefoged, 1967). In this sense, Flege concludes that *equivalence classification* may "prevent learners from producing similar sounds" but not new phones.

For a considerable amount of years, the unidirectional "interference from the L1 was seen as the primary phonological cause of foreign accent" (Flege, 1995a: 235). The topics of research aforesaid, namely the Critical Period Hypothesis, Contrastive Analysis and Categorical Perception, helped to formulate Flege's Speech Learning Model (1995). The SLM was designed in order "to account for age-related limits on the ability to produce L2 vowels and consonants in a native-like fashion" (Ibid: 237). Furthermore, this framework is mainly concerned with the ultimate attainment of an L2 by focusing on bilinguals who have used their L2 for a considerable amount of years.

Throughout the years, Flege and his colleagues have been conducting several studies on second language acquisition (Flege 1981, 1986, 1988b, 1991a, 1992a, b) which proved that this area needed more research in order to explain some interesting results. In this sense, the SLM is based on the following premises: 1) L2 learners are able to successfully perceive the phonetic norms of L2 sounds; 2) L2 speech learning is strongly influenced by quality and quantity input over a significant period of time and 3) the accuracy of L2 speech production is influenced by accurate perceptual representations. Figure 10 presents four postulates and seven hypothesis proposed by the SLM.



Postulates

P1 The mechanisms and processes used in learning the L1 sound system, including category formation, remain intact over the life span, and can be applied to L2 learning.

P2 Language-specific aspects of speech sounds are specified in long-term memory representations called *phonetic categories*.

P3 Phonetic categories established in childhood for L1 sounds evolve over the life span to reflect the properties of all L1 or L2 phones identified as a realization of each category.

P4 Bilinguals strive to maintain contrast between L1 and L2 phonetic categories, which exist in a common phonological space.

Hypotheses

H1 Sounds in the L1 and L2 are related perceptually to one another at a position-sensitive allophonic level, rather than at a more abstract phonemic level.

H2 A new phonetic category can be established for an L2 sound that differs phonetically from the closest L1 sound if bilinguals discern at least some of the phonetic differences between the L1 and L2 sounds.

H3 The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that phonetic differences between the sounds will be discerned.

H4 The likelihood of phonetic differences between L1 and L2 sounds, and between L2 sounds that are noncontrastive in the L1, being discerned decreases as AOL increases.

H5 Category formation for an L2 sound may be blocked by the mechanism of equivalence classification. When this happens, a single phonetic category will be used to process perceptually linked L1 and L2 sounds (diaphones). Eventually, the diaphones will resemble one another in production.

H6 The phonetic category established for L2 sounds by a bilingual may differ from a monolingual's if: 1) the bilingual's category is "deflected" away from an L1 category to maintain phonetic contrast between categories in a common L1–L2 phonological space; or 2) the bilingual's representation is based on different features, or feature weights, than a monolingual's.

H7 The production of a sound eventually corresponds to the properties represented in its phonetic category representation.

Figure 10. Postulates and hypothesis from Flege's Speech Learning Model (Strange, 1995, p. 239)

The first postulate (P1) of the model refers to the notion of plasticity in our perceptual system. Contrarily to the CPH, Flege argues that learners are able to acquire an L2 after puberty as our perceptual system remains intact. In other words, P1 is related to the fact that adult learners are able to perceive non-native phonemes and categorize them. The second postulate

(P2) follows this line of thought and it states that phonetic categories are mentally represented by a phoneme's distinctive features. Moreover, the third postulate (P3) states that due to the plasticity of the perceptual system, learners are able to add and modify L1 as well as L2 phonetic categories and last but not least, P4 states that the phonetic elements present in an L1 and L2 exist in a common phonological space, thus they influence one another.

Deriving from the abovementioned postulates, the SLM proposes seven hypotheses. The first one (H1) states that the sounds found in both phonological systems are perceived accurately when occurring at the same position (Strange, 1992)

In Flege's words, H1 is supported from evidence that "L2 learners are more successful at producing and perceiving certain allophones of English phonemes than others" (1995a, p. 238). The second hypothesis is based on the notion of new sounds and it explains that non-native categories can be established successfully by L2 learners when they perceive the differences between the L1 and L2 sounds. Hypothesis 3 relates to H2: the greater the difference between the L1 and L2 categories, the more likely a new category will be formed for the non-native sound.

Even though the SLM argues that the ability to learn new phonetic categories remains intact over the life span, the model explains that AOL is one of the most important factors influencing SLA (H4). The fourth hypothesis proposes the ability to distinguish between L1 and L2 categories is most likely to decrease as AOL increases. As far as interference is concerned, the SLM suggests that this mechanism is not unidirectional, i.e. L1 only influences L2, but rather bidirectional (H5 and H6). In this sense, L2 also influences L1 perceptually and in speech. In other words, the way a learner produces L2 sounds depends not only on the influence of the L1's phonological system but also on the quality input he/she receives from native speakers of an L2. Consequently, the two language systems influence one another as they exist together in the phonological space (bidirectional interference). The last hypothesis explains that the mental representations of a sound influences the way we produce it. Thus, inaccurate perception of a sound will lead to its inaccurate production.

In the case of word-initial consonants, Flege and his colleagues carried out several studies in which they applied the SLM. For example, Flege, Munro and MacKay (1995b) conducted an experiment where they examined the production of consonants by Native Italian participants who learned English in Canada and differed in their AOL. The results showed that the

participants who began learning English at the age of 10 had produced the English /ð/ and /θ/ in a native-like manner. After that age, a great majority of the participants replaced the fricatives by /d/ and /t/, respectively. In this sense, the number of participants who were judged to produce the fricatives correctly "declined precipitously" (1995b, p. 254)

Another study that focuses on consonants (Flege & Eefting, 1987) was carried out to examine the production of voiceless stops /p/, /t/ and /k/ in Spanish and English. The authors recorded four groups: Spanish monolingual children and adults as well as English monolingual children and adults. The results from the recording showed that the voiceless stops were phonetically realized quite differently: English monolinguals produced the phonemes with longer VOT values than Spanish monolinguals. In order to have a more complete work, the productions of the same phonemes by two groups (adult and children) of early bilinguals were also recorded, and the results proved that AOL has a positive influence on the ultimate attainment of an L2, i.e. children produced the phonemes with longer, more English-like VOT values. Figure 11 compares the results provided by the two groups of early bilinguals as well as the four groups of monolinguals.

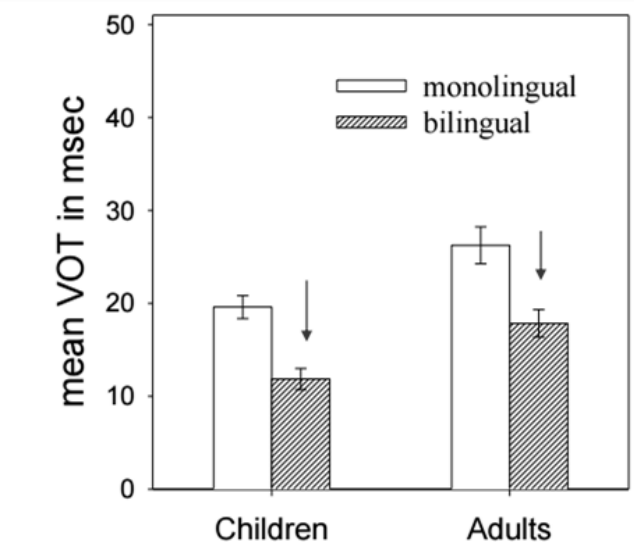


Figure 11. The compared results from Flege and Eefting's study (1987)

As we can see in the figure, the results showed that the process of dissimilation occurs. In comparison with the results from monolinguals and having shorter VOT values, bilinguals

produce the voiceless stops according to the L2's phonetic norms rather than L1's. Although we can see that children have better results than adults, the latter group is still able to form new categories for L2 sounds. Furthermore, it is important to notice that late learners should be given the right kind of input as well as the time needed so that the goal is accomplished.

Flege and Eefting's results also provided evidence of category formation not only for early learners but for late learners as well. Flege and Schmidt (1995) examined how native Spanish, who were learning English at the time they were tested, rated the goodness judgements on the perception of the English /p/ and they also had to produce the phoneme in context. The results supported the idea that late learners tend to categorize L2 phonemes according to the phonological system of the L1. Nevertheless, only four of the fifteen participants produced the English /p/ with VOT values that are equivalent to the Spanish /p/. Moreover, another four participants showed that they perceived the phoneme accurately and produced it correctly as well. Thus, Schmidt and Flege were able to prove that late learners are able to create new phonetic categories as well as early learners.

The following section focuses on the realization of the voiceless glottal fricative by non-native speakers of English, which appears to be problematic in the case of some Romance languages.

1.2 A brief articulatory description of the phoneme /h/

As previously mentioned, phonemes are perceived and produced according to their distinctive features. Hence, the distinctive features are fixed and this means that in order to produce a certain sound, speakers must alter the configuration of the vocal tract so that the sound is produced. As far as European Portuguese speakers are concerned, the English /h/ seems to be quite problematic to realize. By being considered as a non-native sound, these specific learners of English do not have the knowledge on how to modify the vocal tract in order to produce the sound, or rather, they categorize it according to the most similar sound in their L1.

The problem lies in the fact that the initial sound in <hot>, for example, is only represented orthographically in Portuguese (both Brazilian and European varieties). As far as its production is concerned, native Portuguese simply do not produce an aspiration. Even though they realize how English words such as <helicopter> are written, the initial sound is muted by processes of

equivalence classification. Nevertheless, we will focus on and describe where and how this particular sound is articulated in the English system.

1.2.1 Place of articulation

The initial sound in words such as <helicopter> and <Hawaii> is the only sound in English that takes place at the glottis, thus it is called glottal. In this sense, the vocal cords are apart, though not completely, and the glottis open, allowing the airflow to escape through the mouth freely, creating an aspiration. For this reason, as the vocal cords are the place of articulation, /h/ is the only sound in the English language that lacks the typical articulators mentioned in chapter 1.1 (Speech Production).

1.2.2 Manner of articulation

As far as the manner of articulation is concerned, the glottal sound is also described as a voiceless fricative. It is voiceless due to the fact that the vocal cords are apart and the air escapes freely, causing no vibration. Nevertheless, when in context and in proximity with other phonemes, a narrow passage is created as two articulators come close together. Even though there is no complete obstruction, the air is forced to escape through this narrow passage, producing a fricative sound.

1.3 The realization of /h/ by non-native speakers

Several factors have proved to have an influence on the acquisition of the phonological system of an L2. Because of processes of transference and interference between L1 and L2, non-native speakers of English face a great challenge in producing certain phonemes, as is the case of the English /h/ in Romance languages. As aforementioned, the Portuguese phonological system does not have a representation of this sound as English does. Consequently, native Portuguese speakers of EFL usually find this phoneme difficult to produce according to English phonetic norms, resulting in two kinds of misproduction: h-deletion, or omission, and h-epenthesis, or hypercorrection.

In order to examine these occurrences, John and Cardoso (2007) conducted a study whose the main goal was "to identify the linguistic and extralinguistic factors that trigger a higher frequency of h-epenthesis", i.e. what influences the occurrence of /h/ insertion (John & Cardoso, 2007, p. 259). The authors expected that participants would produce instances of h-epenthesis as a result of four main factors: increased formality, occurrence of another /h/ in proximity, stressed syllables[5] and word category, e.g.: function words (*his, her, him, he* and *have*) (2007, p. 264).

A group of 15 adult learners of English, whose L1 was French, participated in the study and their age varied from 27 to 52 years old. Even though the participants were not studying English when they were tested, they had all studied ESL for some years and in different places of instruction. In order to test the degree of formality, the authors divided the experiment into three parts where they recorded very formal, formal and informal speech, respectively (Ibid.). On the one hand the participants had to read several words that consisted in very formal speech and on the other hand the formal speech was analysed by their production of short phrases and sentences. As far as informal speech is concerned, the Francophones were interviewed in a friendly-environment where they answered general personal questions, their hobbies, etc.

The results showed that the insertion of /h/ where it does not occur is greater and mostly seen in stressed syllables as well as with /h/ in proximity, more formal speech and when a pause or a vowel is preceded. As far as omission in concerned, the authors argue that it happens as a result from the absence of /h/ in the francophone phonological system. Nevertheless, the linguistic factors underlying these two inaccurate productions of /h/ will be focused on in more detail, next.

1.3.1 Omission

John and Cardoso argue that h-deletion "is best characterized as a process transferred from the L1" (2007, p. 259) and is mostly seen in people who are starting to acquire English, i.e. in the early ages of acquisition. However, this kind of misproduction is also seen in high proficient learners since the production of this particular phoneme remains adjustable. Native Portuguese

[5] Regarding unstressed syllables, the authors suggest that omission of /h/ occurs as in the case of *historic* vs *prehistoric* (2007: 264).

and Francophones have difficulty when developing this category which results from the absence of this phonetic norm in their underlying representation of English sounds.

As abovementioned, when L2 learners are exposed to a considerable amount of quality and quantity input over time, it is expected that they develop a representation for non-native sounds. Therefore, as L2 learners her to L2 speech it is most likely they will be able to perceive the differences between native English speech and their own speech, i.e. L2 learners are able to perceive the occurrence of aspiration in the initial sounds of words such as <house>. In this sense, native output can have a positive influence on how L2 learners perceive /h/ and as they become aware of the differences, they will automatically correct themselves and imitate native speech. Nevertheless it is important to recall that if the native output (or native speech) is inaccurate, i.e. fails to produce /h/, L2 learners are led to inaccurate perception leading to inaccurate production as well. Moreover, it is important to refer that the English language presents us with words that are orthographically written with the letter h but it is not pronounced (e.g: <hour> and <honest>).

This particular kind of misproduction is one of the most recurrent and is commonly seen in non-native speech. Furthermore, when L2 learners become fully aware of this discrepancy between native and their own output, i.e. they realize the perceptual difference, they are able to produce it as well. However, this often leads them to the other kind of /h/ misproduction, that is, they start to produce an aspiration whenever an English word contains the letter /h/ (2007, p. 206) or even when it does not occur (e.g.: *I hate* [h]apples).

1.3.2 Hypercorrection

The term hypercorrection includes two distinctive forms: qualitative and quantitative (Janda & Auger, 1992). Qualitative hypercorrection is characterized when speakers produce phonetic categories when they do not occur while quantitative hypercorrection happens when L2 speakers "produce more instances of the prestige element in the appropriate context than do speakers of the prestige variety themselves" (2007, p. 262). Given these differences, the process of /h/ insertion is defined as one example of qualitative hypercorrection. As non-native speakers of English try to reach a native-like speech, they tend to produce the aspiration more often in formal speech.

As aforesaid, the results in John and Cardoso's experiment showed that non-native speakers tend to insert /h/ in stressed syllables, with a preceding pause or vowel, with another /h/ in proximity and in very formal speech. Furthermore, they also state that this kind of misproduction comes together with the acquisition of the English glottal and even though it is "associated with the initial stages of francophone ESL acquisition" (2007, p. 265).

There are two cases in which /h/ may not be produced, i.e. aspirated, which may confuse L2 learners during the acquisition of the voiceless glottal fricative. Firstly, the letter h is regarded as a silent letter (i.e. not produced) in some English words such as <honour>, <heir> and <hour>. As Lane explains, the letter h becomes silent in these words[6] because they "came into English from French" (Lane, 2012, p. 116). Secondly, h may be also omitted in function words (i.e..: unstressed pronouns and the auxiliary verb <have>). That is, /h/ may not be pronounced "when these same words occur inside a sentence" (Ibid, 117). For example, when producing the question "Does **he** like apples?" /h/ may be omitted even by native speakers of English while when producing "**He** likes apples", the voiceless glottal fricative is produced at the beginning of the function word <he>.

To conclude, as far as John and Cardoso are concerned, h-epenthesis occurs as a result from the desire of L2 learners to reach the ultimate attainment of the L2, the uncertainty on which English words are initially produced with an aspiration as well as lexical confusion.

The following chapter describes the method used in the experiment that examined the difficulty native Portuguese speakers of English have when producing this particular challenging sound of English.

[6] Another example of a loanword which has the letter h at the beginning but it is not pronounced include <honest> (Lane, 2012).

CHAPTER 2

METHOD

This chapter describes the method of the experimental study. Firstly the objectives of the study, the research questions and hypotheses are presented. Secondly, detailed information about the participants will be provided followed by a description on the testing materials (production and perception tests) used to collect data. Lastly, the testing and analysis procedures are explained.

2.1 Research questions and hypothesis

The present study aims at examining whether the reported difficulties speakers of Romance languages have with the English sound /h/ (John & Cardoso, 2007) will also be observed in Portuguese speakers. Due to the lack of a phonemic representation for Portuguese grapheme <h>, native European Portuguese speakers (henceforth, NEPSs) have some difficulties when producing words such as <house> and <hat> according to English phonetic norms. One example is the occurrence of h-deletion that is transferred from the L1. Even though cognate words such as <hospital> and <hotel> are both present in NPS's L1 and L2, their phonetic realization is different: the initial sound in both words is characterized by an aspiration in English while in Portuguese the grapheme is mute. Consequently, Portuguese learners of English normally articulate /h/ words without producing its distinctive features in L2 speech, particularly in the initial stage of learning.

When EFL learners develop the phonetic representation for /h/, they are able to produce it but tend to produce several instances of /h/ insertion (John & Cardoso, 2007). Moreover, it is interesting to notice that when EFL learners hear words such as <hotdog> and <home> being produced by a native English speaker, they perceive the sound [h] and, generally, seem not to have problem in identifying/ discriminating it (2007, p. 269).

In this sense, as the objectives of this research is to understand the difficulties NPSs have with the target phoneme, the present study seeks to answer the following questions:

RQ1: How do Portuguese EFL advanced learners perceive a "new" L2 phonetic category?

RQ2: How accurately do Portuguese learners produce the English phoneme /h/ in word initial and medial positions?

RQ3: Is there an effect of elicitation technique (word reading vs. picture story description) on the production of the target phoneme?

RQ4: Will Portuguese learners be able to discriminate and identify the target phoneme accurately?

RQ5: Is there a link between the production and perception abilities of Portuguese learners in the acquisition/learning of the target phoneme?

The following hypothesis are based on studies carried out by Flege and his colleagues that focus on second language speech acquisition (Flege, 1986; Flege & Eefting, 1987; Bohn & Flege, 1990; Flege, MacKay & Fox, 1994; Flege & Schmidt, 1995; Flege, 1995a; Flege, MacKay & Meador, 1999; Flege & Liu, 1999, 2001; Piske, Flege and Schirru, 2001). Furthermore, as studies on the acquisition of /h/ by non-native speakers of English, to our knowledge, are scarce, the findings by John and Cardoso (2007) and Osborne (2015) are also taken into consideration. For this reason, it is expected that:

1. Portuguese learners will be able to perceive the new phonetic category accurately, due to the non-existence of an L1 counterpart in the Portuguese phonological system, according to the SLM (Flege, 1995);
2. Portuguese learners will be able to produce the new category accurately (Flege, 1987);
3. Word reading will elicit more foreign-accented productions, that is, more deviations from the English phonetic realizations than the more extemporaneous elicitation technique (Oyama, 1976; Thompson, 1991);
4. Learners will discriminate the target phonetic category better than identify it. (Best & Tyler, 2007)
5. Perception of the target phoneme will be correlated with production, but not to the same extent. The target phoneme will be more accurately discriminated/identified than produced (Flege, 1993)

2.2 Participants

Two different groups participated in the study: an experimental group of native Portuguese speakers who performed the production and perception tasks; and a group of British English speakers who had lived in the United Kingdom, namely in Scotland and England, since they were born. These NESs (Native English Speakers) contributed in the research by providing the material needed to set up the tasks for the perception test.

2.2.1 L2 speakers

The cohort of the L2 participants consisted of 38 adults who were majoring English in the *European Languages and Literatures* degree course at the University of Minho, Braga (Portugal) and had an average of 11 years of L2 formal instruction. In order to recruit L2 learners of English, the researcher went to a class of the course *English Linguistics 1 – Phonetics and Phonology* to ask for the students' voluntary participation in the study.

A calendar (see Annex A) was made available to the class and those who were willing to participate wrote his/her name according to his/her availability. Moreover, the same calendar was put online so that all students could have access to it and fill in their names at the most convenient times. Students were given extra course credit for participating in the study but no monetary compensation was provided.

The L2 learners were selected according following inclusionary criteria: (1) be native speakers of Portuguese (L1); (2) have started learning English at an early age, i.e. between 6 and 10 years old, (L2); and (3) were majoring English at the university at the time of data collection. All of the 38 volunteers were informed about the procedures and the main purposes of each task. However, more specific information was not given so that their performance would not be influenced. From the initial 38 participants, one had to be excluded because s/he was not a native speaker of Portuguese.

The study was carried out with the participation of 37 adults who are studying EFL and their age varied between 18 and 22 years old (mean= 19.24 years, SD= 1.321). The experimental group consisted of 26 female (70.27%) and 11 male (29.73%) participants. The L2 learners' AOL varies from 5 to 11 years old (mean= 8.06 years old, SD= 1.613) and 30 of them started

learning English in Public Schools (81.1%). Moreover, the years of instruction as far as English is concerned varied from 8 to 15 years (mean= 10.85 years, SD=1.726).

The English level proficiency was assessed according to the levels described in the CEFR and the required level for each semester of the degree[7]. Thirty-six students were in the first year and only one was in the second year. Nevertheless, as aforesaid, all students were enrolled in *English Linguistics 1 – Phonetics and Phonology* course, taught in the second semester of the first year, and had acquired the level of B2 at the end of the first semester. Given that the study was conducted in the second semester of the year, all of the participants were enrolled in English B2+ level classes by the time they were tested.

2.2.2 L1 speakers

The group of L1 participants included three native English speakers (NESs), two male and one female, whose age varied from 25 to 60 years old (Mean= 48 years, SD= 19.925). Each L1 participant was born in United Kingdom, two of whom were English and one was Scottish. All of them reported speaking English on an everyday basis and use Portuguese for an average of 20 hours per week. This group participated voluntarily in the experiment by providing the stimuli needed for the perception task.

The L1 participants were asked to fill in a background questionnaire which provided biographic information such as age, gender, native language, occupation, and length of residence in Portugal (see Annex B). Table 1 summarizes biographic information of this group.

Table 1. Background information of the native English speakers

Part	Sex	Age	Place of birth	Current residence	Occupation
1	M	25	England	Portugal	Teacher
2	M	60	Scotland	Portugal	Farming
3	F	59	England	Portugal	-[8]

Note: M= Male; F= Female

[7] In the first year of the European Languages and Literatures, students are expected to acquire the level of B2 at the end of the year; Second-year students study the level of C1 and when they finish the degree, they are expected to acquire the C2 level (third-year students).

[8] The NE participant did not answer this question.

The group of NESs was also informed about the topic of the research, its objectives and the benefits of the experiment as well as the procedures of the recording session to which they agreed to participate.

2.3 Materials

This section describes the materials used to collect data related to L2 learners' biographic information as well as their background knowledge on FLs, namely English. Moreover, it is also included a description on how the production and perception tests were designed.

2.3.1 Questionnaires

The L2 learners agreed to participate in the study, voluntarily, by signing a consent included in the questionnaire[9] (see Annex C). Additionally, they filled in this questionnaire which was written in English due to their advanced level of the target language. In the survey, the students provided detailed information about their L1 and L2 background as well as their knowledge of other FLs (see Annex D).

By being enrolled in an English course, the L2 learners reported speaking the L2 on an everyday basis. When asked whether they use the language outside the classroom, 34 people (91.9%) answered positively and the majority of them (37.8%) said they use English between 15-30 minutes per day. Even though a great majority of the participants (78.4%) reported having a B2 level of proficiency, seven (18.9%) claimed having C1 and one student (2.7%) reported having a C2 level of English proficiency. From the group of eight participants with a higher level of proficiency, four claimed having studied English at private language schools while the remaining four only attended public schools.

Moreover, participants also provided information about the usage of English in leisure times, namely TV series, movies, music and games. As expected, all of the students claim that they watch TV series and movies and 22 (59.5%) of them spent 1h-2h each day on this activity. When asked about the use of subtitles 16 (43.2%) responded positively while 21 (56.8%) claimed

[9] All the 38 students volunteered to participate in the research, all of whom answered the questionnaire. However, since the study focuses on NPSs of EFL, 1 participant was excluded because the following criterion was not met: be native speakers of Portuguese (L1).

not using subtitles. From the 16 students, 11 (83.8%) choose the English language and 5 (2.7%) prefer Portuguese subtitles. As far as music is concerned, 59.5% of participants claimed spending more than 2h listening to music in English. Moreover, 8.1% of the students spend between 15 to 40 minutes per day while 24.3% devote 1h-2h of their time to this activity. Regarding games, 21 participants (56.8%) play video games in English and 37.8% of this group, spend 15-40 minutes on the activity.

2.3.2 Testing materials

This part of the dissertation describes how both production and perception tests were designed and the adopted procedures.

2.3.2.1 Production

In order to analyse how the voiceless glottal fricative is phonetically realized by native European Portuguese speakers of L2 English, a production test was conducted. The test was divided in two tasks: the first was a word-reading task and the second was a narrative production task. In the first task, participants were asked to read 48 words in isolation and in the second task participants were asked to tell a story about 5 pictures, which included 11 objects that had the target phoneme in word-initial position. The recordings were made with an *Edirol R-09HR* recorder and an *Edirol CS-15* microphone.

2.3.2.1.1 Stimuli

In the first task of the production test, the isolated words with the target sounds were presented with PowerPoint slides (see Figure 12). Each of the 48 slides (see Annex F) presented an image that illustrated a specific word in English. Twenty-four of those images represented words with a word-initial /h/ sound (e.g.: <heart> and <honey>) and the other 24 words had a vowel as initial sound (e.g.: <island> and <ankle>). Before the test, 5 extra words were included to familiarize the learners with the task.

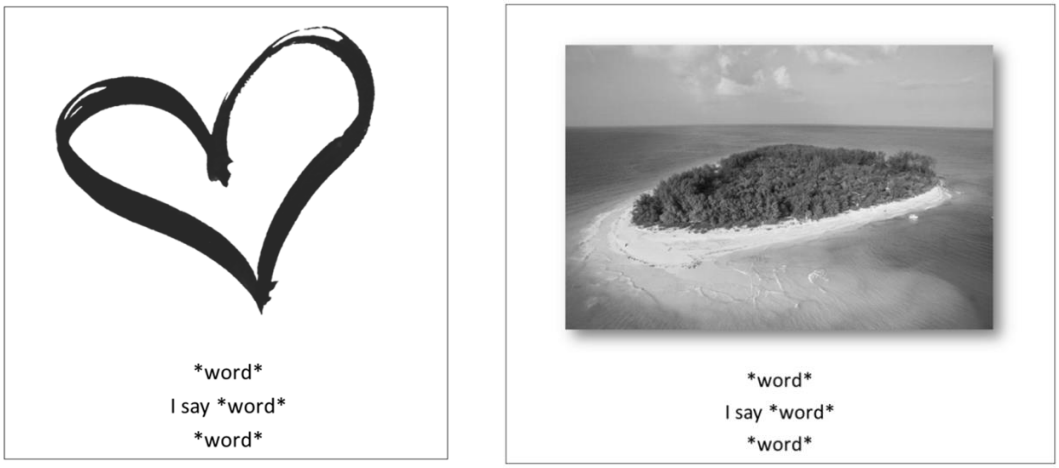


Figure 12. Examples of the images used for the first production test.

As it can be seen in Figure 12, besides having an image, each slide also contained instructions on how to produce the target words. They were thus asked to say the target word, then embed it in the carrier sentence "I say *word*", and then repeat the word in isolation. L2 learners were asked to produce the same sequence twice throughout the test so that two instances of the same /h/ word in isolation and in context were collected for analysis, totalling 96 productions.

The second task of the production test was designed as a picture story. The researcher created a picture story divided into 5 different pictures (corresponding to 5 different actions) that included 11 words with the target phoneme (see Annex G) in word-initial position: hamburger, hawk, helicopter, high heel, hockey, honey, horses, hospital, hotdogs, house and hyena.

This specific task aimed at avoiding the interference of orthography and collecting the learners' production in a more spontaneous register. None of the students had previous knowledge of the objective of this task so that their speech would be as spontaneous and natural as possible.

2.3.2.1.2 Procedures

The production test took place in a quiet room at the University of Minho according to the calendar abovementioned. A friendly-like conversation was carried out in order to make participants feel more comfortable with the task. The procedures of this task were explained to

every single participant but more detailed information was not disclosed so that they would not be influenced and become aware of the target phoneme under study. Moreover, the researcher also expressed that they could take a pause to rest for a minute or two whenever they wished to.

Before the recording, the researcher showed all the images once to the participants so that the correct target words were elicited. Whenever they did not know the words, the researcher asked questions so that the target word was elicited (e.g. asking for synonyms or antonyms). By doing so, no model production was provided and therefore no influence from a third party would affect L2 learners' production.

The first five pictures were included to familiarize the participants with the task followed by the 48 target words, but were not included in the analysis.

All the participants repeated each target word twice. Hence, 288 (3 productions x 2 repetitions x 48 pictures=288) productions of the target words were recorded in the first task of the production test.

The second task involved narrating a story based on a sequence of five pictures. The pictures were displayed on the table in a random order. Firstly, the participant was asked to describe each picture and the 11 target words were elicited. When the participant missed one of those words, they were asked to describe what else they saw in the drawings before going to the next one.

After all the words had been produced, the participants were given a couple of minutes to create a simple story that included the five drawings. Having created the story, they shared the narrative so that nothing would be forgotten and they would feel less nervous before it was recorded. Next, their production of the story was recorded and the task completed.

2.3.2.2 Perception

The perception test was designed in order to examine L2 learners' ability in discriminating and identifying the target phoneme. The following sections describe how the task was designed.

2.3.2.2.1 Stimuli

The stimuli used in the perception test were recorded by the three native English speakers. The recording session took place at the University of Minho in a room which included sound-attenuated booths. The devices used in the production test were also used in the recording of the stimuli for the perception test.

The stimuli were presented in PowerPoint slides which were divided into two parts: the first included stimuli that were going to be used in the discrimination task and the second part consisted of English sentences for the identification exercises. We will focus now on the description of these two parts, starting with the discrimination test.

The stimuli used in the discrimination test (see Annex H) consisted of 70 English real words (e.g.: hair, air, heart, art) half of which had /h/ as the initial sound and the other half had a vowel in word-initial position. Some minimal pairs were created, i.e. pairs of words which only differed in their initial sound (with or without /h/). Table 2 shows some examples of minimal pairs.

Table 2. Examples of minimal pairs used in the discrimination test

With /h/	**Without /h/**[10]
Hate	Ate
Hedge	Edge
Hit	It
Hold	Old

After all the stimuli were recorded, the files were edited and segmented using *Praat* and *Audacity 2.02* software. In order to normalize intensity in the recordings, a Praat script (Annex I) was run and noise was removed by using *Audacity*.

The stimuli were segmented using the program *Audacity* and saved as wav files. By using *Praat*, three stimuli were concatenated with an inter-stimulus interval (ISI) of 1.2 seconds. The stimuli were organized in sequences of three tokens, i.e. trials produced by three different NESs.

[10] All pairs labelled "without /h/" had a vowel in word-initial position.

The discrimination test was an oddity task in which an odd stimulus could be heard in one of three positions (Mompean & Fouz-González, 2015, p. 298). In this sense, participants had to decide in which position the odd sound was, i.e. first, second or third position in the triad.

As the position of the odd sound varied, participants were expected to identify the odd sound in the first, second or third position. For example, when they hear the trial "had-ad-ad" they were expected to choose the first token as the odd sound. This is an example of "change trials", i.e. trials in which one token is different from the other two. However, when they heard sequences in which the three tokens included the same phonemic category in word-initial position (e.g.: "had-had-had") listeners were expected to perceive the absence of an odd sound. Thus, this kind of sequences is named as "catch trials" (Flege & Meador, 1999, p. 2978). Table 3 provides an example of the trials using one minimal pair (hair; air).

Table 3. Example of change and catch trials used in the experiment

Change trials	**Catch trials**	**Change trials**
M2_hair; M1_air; F1_air	**M1_hair; F1_hair; M2_hair**	**F1_air**; M2_hair; M2_hair
M1_air**; F1_hair**; M2_air	**M2_air; M1_air; F1_air**	M2_hair; **M1_air**; F1_hair
F1_air; M2_air; **M1_hair**		M1_hair; F1_hair; **M2_air**

Note: M1 – Male 1; M2 – Male 2; F1 – Female.

The discrimination test was uploaded to software *TP 3.1* (Rauber et al. 2012) which was developed for speech perception experiments. The discrimination test was divided into two tasks (a familiarization phase followed by the test). Before moving from one task to another, all stimuli were presented in a random order to avoid any ordering effects and the trials used in the familiarization were not included in the discrimination test. Familiarization aimed at acquainting L2 listeners with the response buttons and procedures as well as adjusting the volume at a comfortable level. A total of 16 trials were used in this phase (8 sequences x 2 repetitions =16).

The oddity discrimination test consisted of 126 stimuli. A pause was inserted after the presentation of 50 stimuli so that participants could rest. When the discrimination task was

completed, *TP* automatically displayed the cumulative results on the screen so that students would have some feedback on their performance.

The identification test focused on the identification of the target segment embedded in words in simple and short sentences (e.g.: <It's a scary **h**owl> and <It's a scary **o**wl>). The identification test, which included two tasks, was also preceded by a familiarization phase. In total, 104 sentences (see Annex J) were presented randomly in the perception test.

The familiarization task included 12 sentences (6 sentences x 2 repetitions=12). By having the same design as the identification tests, it was set to help participants get accustomed to a different task from the discrimination one and its button responses.

In the first task, L2 learners' had to identify the initial sound of the first word of the sentence (e.g.: <**E**at that up!> and <**H**eat that up!>). Two response options were provided: "No /h/" and "/h/". Thirty-four sentences were included and were repeated twice, giving a total of 68 sentences (34 sentences x 2 repetitions=68).

In the second task, EFL students were asked to recognize the initial sound of a word in sentence-medial position (e.g.: <My **h**eart is blue> and <My **a**rt is blue>). In total, 24 sentences were played (12 sentences x 2 repetitions=24).

Furthermore, from the 104 sentences used, 16 functioned as distractors. Some of these sentences did not have any /h/ word or started with a vowel (e.g.: <She's from Japan>) and other included words that were not minimal pairs (e.g. <This is my home> vs <This is my Omen>).

All the tasks included in the perception tests (discrimination and identification) included a replay button so that participants could replay the stimulus once in case it was not heard.

2.3.2.2.2 Procedures

The perception task was done in a tutorial class of *English Linguistics 1 – Phonetics and Phonology*. This particular task was carried out in a computer-lab at the University of Minho and each participant was provided with a computer and set of headphones (brand NGS, model

MSX6Pro). The *TP 3.1.* software with the perception tasks had been previously installed and run in each computer to verify its functionality.

The 38 participants were alphabetically divided in two groups, equally numbered. The perception test session had a duration of 50 minutes, 10 of which were used to give the instructions for the task and the remaining 40 minutes were used to complete the task. The instructions were given in English (see Annex K) and complemented with a PowerPoint presentation with examples of the task.

Participants were advised to start with the discrimination test followed by the identification test. The instructions for the discrimination task were also included in the program and all participants could have access to them through the task.

In the discrimination test participants heard a sequence of three words (a triad) produced by three different talkers. The L2 learners could hear the trial again by clicking on the replay button. They were asked to distinguish whether the three words were the same or different. If they were the same (catch trials) students would click on the button "same" and when the words were different (change trials) they had to choose in which position was the odd sound. For example, when the triad <had-had-had> was produced, participants should click on the response button "Same" as the words have the same initial sound but when the triad <had-ad-had> was played, they should click on the response button "2" since the odd sound is in position 2 (see Figure 13).

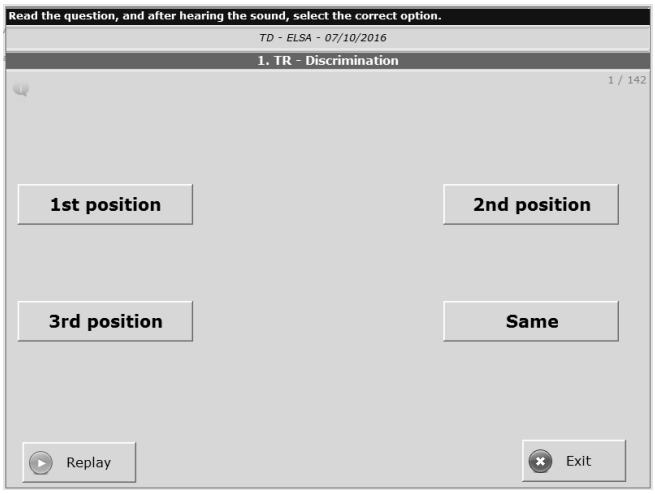


Figure 13. Print screen of the discrimination task.

In total, participants heard 126 trials. When the discrimination test was completed, their results were displayed on their computer screen and they moved on to the identification test.

The second perception task (identification) was also designed by using *TP 3.1* and the procedures were similar to the abovementioned one. This task was divided in three parts and included 104 sentences. By having the sentences randomized, students were not able to form a pattern which could influence their performance and, whenever the stimuli were not heard, they could replay it once.

Participants heard the target words and had to choose if the word included the /h/ sound in word-initial position or not (see Figure 14).

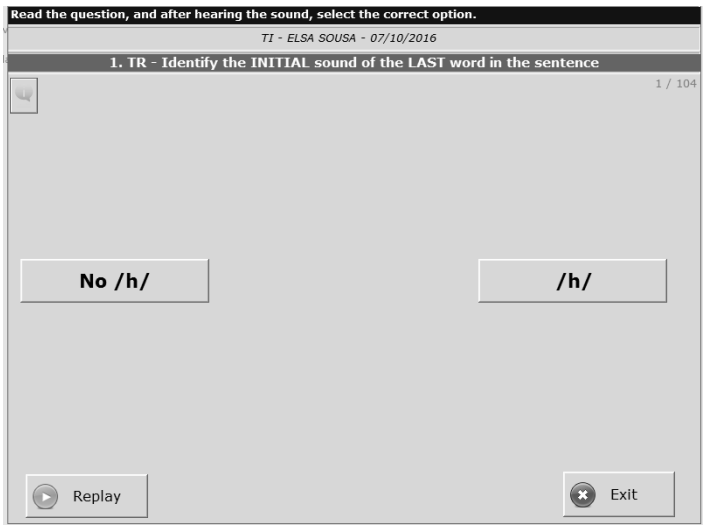


Figure 14. Print screen of the identification task.

When this task was completed, a window automatically appeared and participants were informed that another test would start when they clicked on the "OK" button. This second task aimed at testing L2 learners' ability in recognizing whether the initial sound of the last word was produced with /h/ or no /h/, similarly to the previous task.

In the third identification task participants identified whether the initial sound of the last word in the sentence was produced with or without /h/ (e.g. <This is home> and <This is my omen>).

In sum, the identification test included the stimuli with the target sounds in three different positions: at the beginning of the sentence (initial), in the middle of the sentence (medial) and at the end of the sentence (final). After the identification test was completed, the results were displayed and participants were provided with cumulative feedback.

2.4 Data analysis

In this section it is reported how the data collected from the tests was organized and analysed. First, we will focus on the analysis of the production data followed by the perception data.

2.4.1 Assessment of Production data

As aforementioned, the first five productions of the familiarization task of the word-reading production test were not included in the data analysis. Hence, the remaining 48 target stimuli were examined. Furthermore, as the target words were produced three times in each slide and repeated twice, 288 stimuli (48 slides x 2 repetitions x 3 productions= 288) were examined.

The recording files from the production data were first normalized by running a *Praat* script (Annex I) and noise was removed with *Audacity*. The audio files were then analysed with *Praat* so that the researcher could observe instances of h-epenthesis and h-deletion through the visual inspection of soundwaves and careful listening.

The main acoustic feature in the production of the English glottal fricative is aspiration, so the realization of the target sound could not be mistaken for any other (i.e., it could only be either aspirated or not). The analysis focused on the production of the target phoneme in context of the carrier sentence <I say *word*> since one of the main objectives is to examine the realization of /h/ in context rather than in isolated words (see figure 15 and 16).

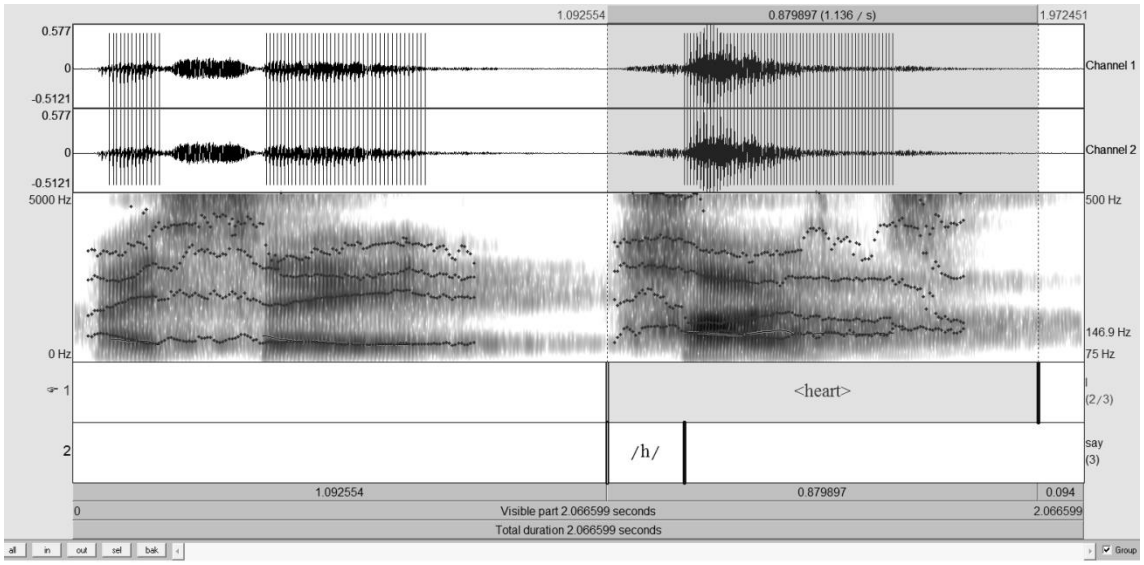


Figure 15. Soundwave provided by *Praat* of the sentence <I say **heart**>

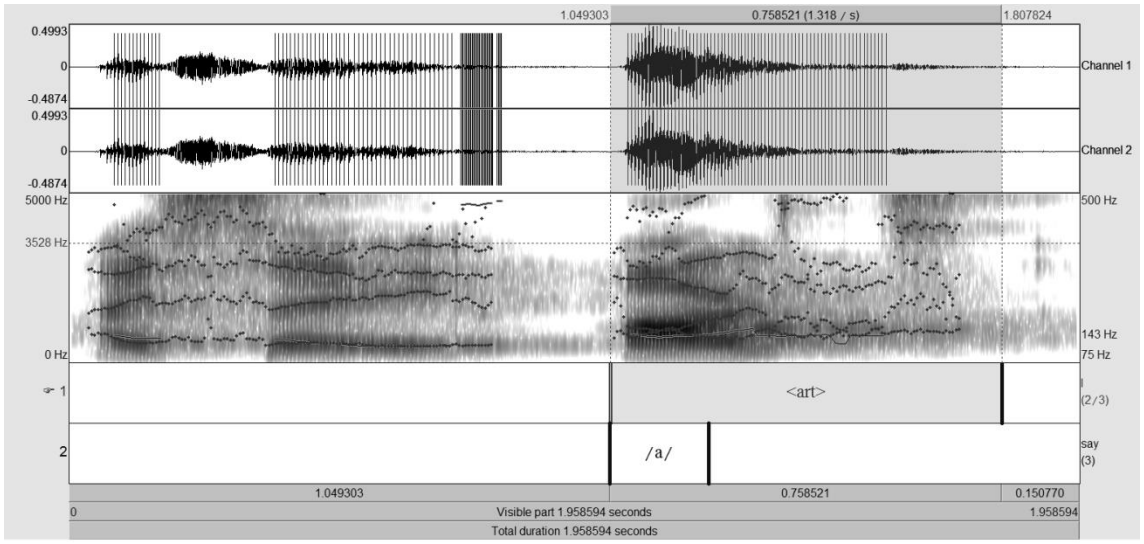


Figure 16. Soundwave provided by *Praat* of the sentence <I say **art**>

The data were saved in an Excel spreadsheet, which included the results obtained from the production of words that have /h/ as its initial sound (e.g.: <heavy>) followed by the results from the production of words that start with a vowel (e.g.: <ill>) and the third part focused on other types of misproductions that were recorded. Each part was divided in 4 columns, as explained next.

The first part, i.e. the results obtained from the production of /h/ words, was divided in 4 columns. Table 4 illustrates how the production data related to the first production test was organized.

Table 4. Organization of the data collected from the first production exercise (words that have the target phoneme in word-initial position)

Participant	/h/	%	1/2 Productions	%	Omissions	%
1	18	75.00	4	16.67	2	8.33
2	16	66.67	3	12.50	5	20.83

The first column represents the code number attributed to L2 participants. The next one provides the total number of correct productions of the words in which /h/ is produced in word-initial positions. As participants repeated the stimuli twice, the fourth column refers to the number of times they produced the aspiration only half of the time. For example, when producing the target sentence <I say hair>, participant X firstly produced /h/ accurately (i.e. <I say hair>) while in the second time, s/he omitted it (i.e. <I say air>). Therefore, this participant produced the English glottal only half the time. The sixth column refers to the total number of times L2 learners produced instances of h-deletion, that is, did not produce the target sound. Moreover, the coloured columns show the respective percentage which would be later needed for statistic calculations.

Similarly, the words used to analyse instances of h-epenthesis were also organized and firstly assessed in the same document. Four main columns are related to L2 learners' list number, total number of words correctly produced, number of half productions and the number of h-epenthesis occurrences, respectively. The numbers were also converted into percentages to facilitate statistical analysis (see Table 5).

Table 5. Organization of the data of production test 1 (words beginning with vowels)

Participant	No /h/	%	1/2 Productions	%	Insertion	%
1	16	66.67	7	29.17	1	4.17
2	17	70.83	5	20.83	2	8.33

A third part of data assessment was added due to the occurrence of other types of misproduction. This part was divided in two columns which accounted for the number of different type(s) of misproductions and their labels.

The second exercise of the production task consisted in the narration of a story by having 5 images as reference. In each image there were illustrations of /h/ words such as <horse>, having an overall of 11 key-words that were elicited. Each audio file was analysed by using *Praat*, having segmented each /h/ word and document the number of times the target phoneme was produced correctly. Even though there were 11 key words participants had to produce, the majority of them included other words with the target phoneme (e.g.: <holidays> and <hurt>).

The data of this exercise was firstly documented and assessed in an Excel spreadsheet as well. Table 6 illustrates its organization.

Table 6. Organization of the data collected from the second production exercise (story)

Participant	**Number of words produced**	**Correct productions**	**Percentage**	**Other types of misproduction**
1	11+2	10	76.92	1 [aɪ'**h**i:nə]
2	11+2	11	84.61	

Next to the participant's column, the total number of words produced is registered, those which have /h/ in the beginning (key-words plus the extra words). These included both correct productions as well as incorrect ones. The next column documents the number of accurate productions as far as those words are concerned. Its percentage was calculated by dividing the number of accurate productions by the total number of /h/ words produced. For example, participant one produced 13 words which have /h/ as the initial sound. However, only 10 of the 13 words were produced accurately, resulting in 76.92% of its accurate productions.

The production data were organized and exported to the program *IBM SPSS Statistics version 23* for statistical analysis. Descriptive analysis were run in order to summarize the data related to participants followed by inferential analysis to compare the mean correct percentages regarding our two variables of analysis (/h/ and no /h/) in the production and perception tests.

2.4.2 Assessment of Perception data

The analysis of the perception tests was carried out after extracting the results automatically provided by the software *TP 3.1*. The discrimination and identification results were automatically registered in Excel spreadsheets.

The total number of stimuli of the oddity discrimination tasks that were analysed was 126 and the total number of the identification test was 74 stimuli.

Regarding the discrimination task, the variables in analysis (i.e. words with /h/ in word-initial position and words which started with a vowel) were organized separately. Descriptive analysis was carried out in order to determine the mean correct percentages of each variable. Hence, we analysed the participants' ability to perceive the presence or absence of /h/ as well as the percentage of hits according to the position where it occurred (see Table 7 and 8).

Table 7. Organization of the results of the discrimination test (trials without /h/)

Participant	Total without /h/	1st position	2nd position	3rd position	Same
3	84.37	100.00	75.00	75.00	68.75
4	64.06	43.75	75.00	75.00	62.50

Table 8. Organization of the results of the discrimination test (trials with /h/)

Participant	Total with /h/	1st position	2nd position	3rd position	Same
3	83.87	93.75	87.50	87.50	64.28
4	58.06	75.00	68.75	50.00	35.71

As far as the identification test is concerned, the results were organized in a simpler way. Three columns were needed, one for the total percentage of the correct answers in the identification test as a whole; another for the percentage of hits according to the variable words

with /h/ in initial position and the latter for the stimuli that included words with vowel-initial position (see Table 9).

Table 9. Organization of the results of the perception test

Participant	Total percentage	/h/	No /h/
3	93.05	94.44	91.66
4	83.33	83.33	83.33

The data of the perception task was then exported to *IBM SPSS Statistics version 23* as well. Descriptive and inferential tests were also applied in order to compare mean percentages of correct and incorrect answers and investigate whether there were differences between the discrimination and identification tasks performed by L2 learners.

The following chapter describes how these tests were run in the statistical program, *IBM SPSS* version 23, followed by a discussion on the results.

CHAPTER 3

RESULTS AND DISCUSSION

This chapter presents the statistical results obtained from the production and perception data analysis. Firstly, it is reported the descriptive analysis of correct and incorrect productions in P1 and P2, separately. Secondly, mean percentages of accurate productions of the two variables (i.e. /h/ in word-initial position and words starting with a vowel) were compared by running *t* tests to investigate the treatment of /h/ in isolation and in context. Mean percentages of misproductions were also compared in both tests to investigate what type of misproduction occurred more frequently in P1 and in P2. Next, a descriptive analysis was carried out in order to show the results of the discrimination and identification tasks separately. *T* tests were run to investigate if L2 learners have more difficulties in identifying or discriminating the voiceless glottal fricative. Moreover, correlational analysis of the two sets of data was carried out to investigate the relation between production and perception. Finally, the findings will be discussed in light of previous studies and the theoretical speech learning model (Flege, 1995).

3.1 Production test

As described in Chapter 2, the data was collected by means of a production test divided in two tasks: the first task (P1) aimed at eliciting the production of words with the target phoneme in isolation, i.e. word reading; the second task (P2) aimed at investigating the production of the target phoneme in a narrative and semi-spontaneous context, i.e. a picture story narration.

Exploratory analysis of the production data was carried out to verify if the results had a normal distribution. Therefore, the Kolmogorov-Smirnov (K-S) and the Shapiro-Wilk (S-W) tests were applied and they revealed that the production data had a normal distribution ($p > .05$). Moreover, we looked at the values of skewness[11] and kurtosis[12] as they also demonstrate data distribution. Since the values for these two measures varied between -1 and 1, it was also confirmed that Production data had a normal distribution (Martins, 2011, p. 226). Therefore, parametric tests were run in order to analyse the results of the production tasks.

[11] The term skew refers to the lack of symmetry of results. Therefore, "the further the value is from zero, the more likely it is that the data are not normally distributed" (Field, 2009, p. 139)

[12] Kurtosis "refers to the degree to which scores cluster at the ends of the distribution (known as the tails) and how pointy a distribution is" (Field, 2009, p. 19)

The accurate productions of both words with /h/ in initial position and words with vowel-initial position were compared in the two tasks to assess whether there were differences in terms of correct productions in P1 and P2. Within-subjects *t* tests were run and the results are displayed in Table 10.

Table 10. *T* tests results of the mean correct percentage from the Production task (/h/ in word-initial position)

	P1 (n= 37) Mean (SD)	**P2 (n= 37) Mean (SD)**	***t* (df)**
With /h/	86.37 (13.34)	74.14 (19.95)	4,110 (36)***
Without /h/	66.89 (30.96)	96.75 (4.492)	-6,213 (36)***

Note. N= number of participants; SD= Standard Deviation; *t*= result of the *t* test; df= degrees of freedom; level of significance: *p< .05, ** p< .10, ***p< .001.

The results showed that there were significant differences between the production of /h/ as far as the elicitation technique is concerned (i.e. word reading and picture story description), *t* (36) = 4,110, p< .001. The participants produced the target phoneme more accurately in the word reading task (P1) than in the picture story narration (P2). Additionally, there were also significant differences in the production of vowel-initial, i.e. words without initial /h/, *t* (36) = -6,213; p< .001, revealing that the participants produced these words more accurately in the same task.

When comparing the mean percentage of correct productions of both production tasks (P1 and P2), the results indicate that L2 participants produced the target phoneme more accurately in P1 (86.37%). On the other hand, words without /h/ were more correctly produced in context (96.75%) rather than insolation, as we can see in figure 17. Thus, we can conclude that the production of/h/ is more accurate in isolation while vowel-initial words (without /h/) are more correctly produced in spontaneous speech.

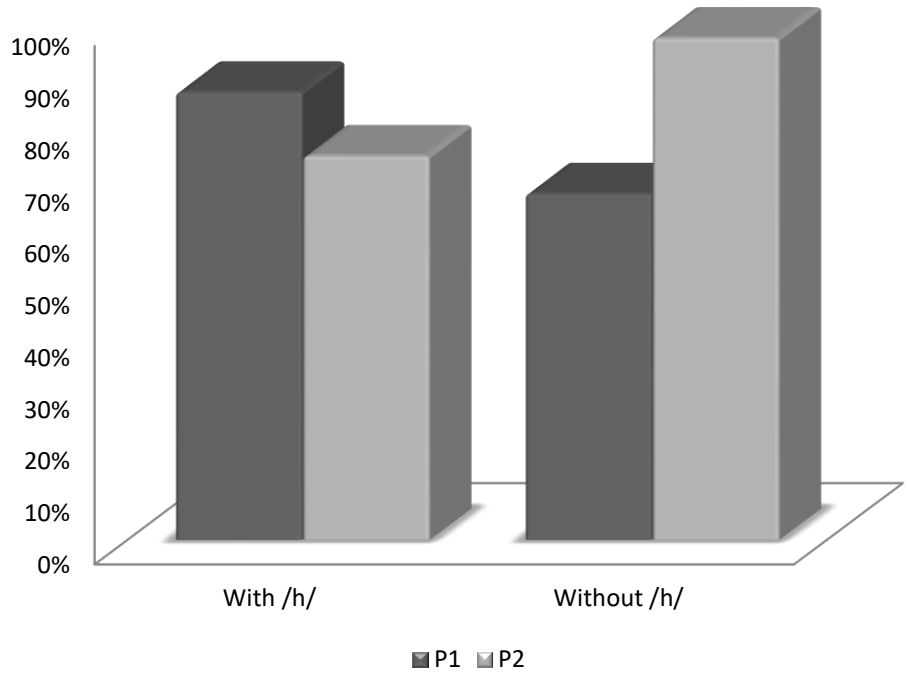


Figure 17. Mean percentage of accurate productions in P1 and P2.

Figure 18 shows the mean percentage of the correct and incorrect productions in P1. The incorrect productions were furthered analysed and divided into three categories: insertion (or h-epenthesis), omission (or h-deletion) and other types of misproductions (namely, the insertion of /h/ in the middle of the word <hyena>[13]). As we can observe in figure 16, participants produced words starting with the voiceless glottal fricative more accurately (86.37%) than vowel-initial words. Regarding incorrect productions, the bar graph illustrates that instances of h-epenthesis were produced more often (49.93%) than omission (38.36%) and other types of misproduction (4.11%).

[13] Examples of misproductions of the word hyena: [haɪ'**h**i:nə] and [aɪ'**h**i:nə]

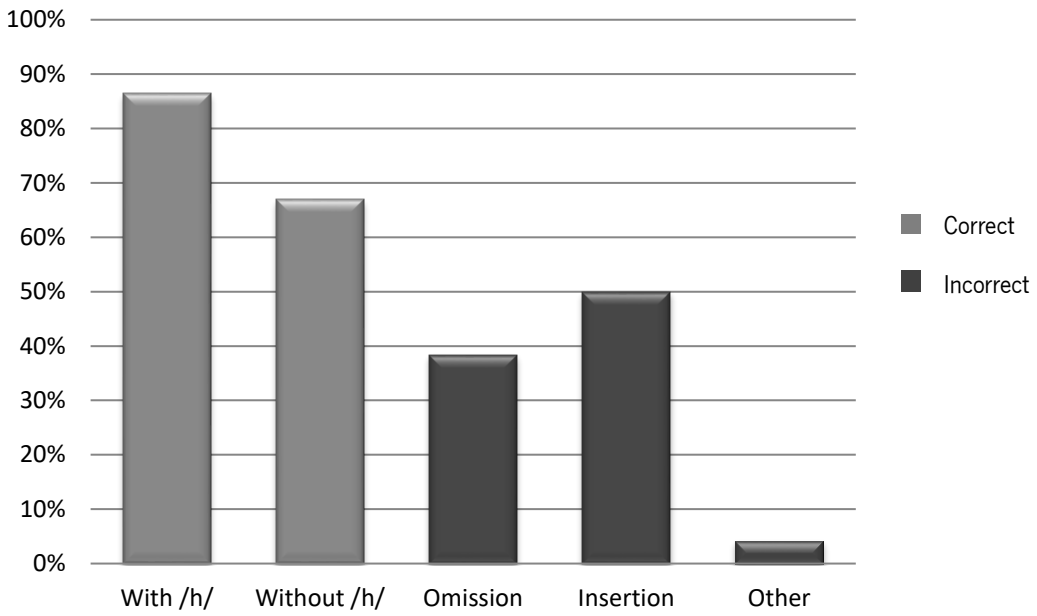


Figure 18. Mean percentages scores of P1.

Descriptive analysis was carried out for the instances of half-productions[14] in P1. The results revealed that words with the target phoneme were half produced more frequently (mean= 37.37%; SD= 38.60) than words without /h/ (mean= 29.74%, SD= 29.97).

In the picture story task, participants obtained higher accurate scores in the production of words without /h/ (96.75%) contrary to P1 (see figure 19). Furthermore, the type of incorrect production that occurred more often was h-deletion (64.89%), while insertion obtained a mean percentage of 37.84% and other types of misproductions 7.88%.

[14] In P1, participants had to repeat the same line twice. Half productions refer to cases in which participant X produced the target sentence "I say harrow" in two different ways. For example, the first time s/he produced "I say harrow" and the second time s/he produced "I say arrow".

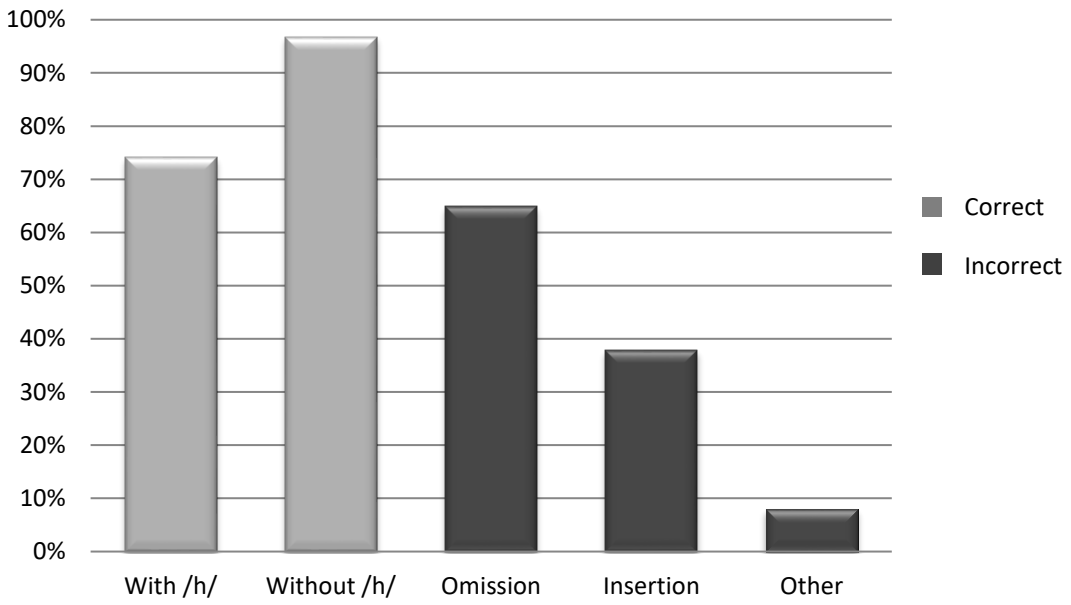


Figure 19. Mean percentages scores obtained in P2.

As far as incorrect productions are concerned, the results obtained from the *t* tests showed that the misproduction of /h/ is significantly different in P1 and P2, t (36) = -4,110, p<.001. There are marginally significant differences related to insertion, t (36) = 1,950; p< .10, which was produced more in the word-reading test, while instances of omission and other types of misproductions are significantly different and realized more frequently in P2 (see Table 11).

Figure 20 illustrates the mean percentages of the three types of incorrect productions in both production tasks. L2 participants produced more instances of omission (64.89%) and other types of misproductions (7.88%) in spontaneous speech. On the other hand, h-epenthesis tended to be produced more often in the word-reading task (49.93%).

Table 11. *T* tests results of the mean percentage of incorrect productions in the Production task (words with /h/ in initial position).

	P1 (n= 37) Mean (SD)	**P2 (n= 37) Mean (SD)**	***t* (df)**
Total	13.63 (13.34)	25.86 (19.95)	-4,110 (36)***
Insertion	54.04 (36.10)	37.84 (49.17)	1,950 (36)**
Omission	38.36 (38.93)	64.89 (40.33)	-3,377 (36)*
Others	4.11 (16.63)	7.88 (19.14)	-2.074 (36)*

Note. N= number of participants; SD= Standard Deviation; *t*= result of the *t* test; df= degrees of freedom; level of significance: *p< .05, ** p< .10, ***p< .001.

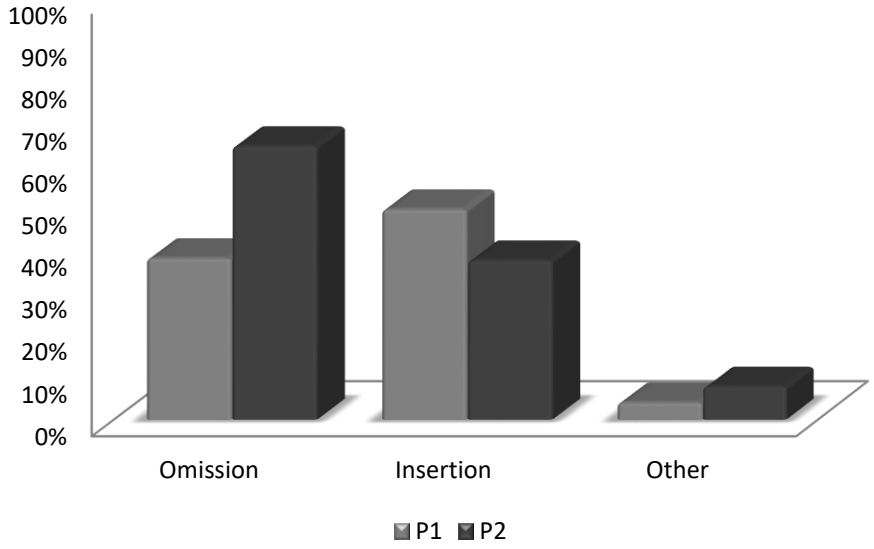


Figure 20. Mean percentage of incorrect productions in P1 and P2.

Overall, we can conclude that the target phoneme was more inaccurately produced in P2 rather than in P1. The results show that different elicitation techniques had an effect on the treatment of /h/ by L2 learners, that is, the English glottal fricative was more accurately produced in isolation and in a rather controlled environment than in semi-spontaneous speech. As a result, the word-reading task promoted more accurate productions of /h/.

3.2 Perception test

The perception test was divided into two main tasks: identification (ID) and discrimination (DISC). Exploratory analysis was also carried out to assess whether perception data had a normal distribution. The Kolmogorov-Smirnov (K-S) and the Shapiro-Wilk (S-W) tests were applied and they revealed that only the scores of the ID test, did not have a normal distribution and due to an outlier[15]. After excluding this outlier[16] from the analysis we run the K-S and S-W tests again, and the results, along with the values of skewness and kurtosis, confirmed that ID data had a normal distribution. Thus, parametric tests were run for the statistical analysis of the perception data, collected from 36 participants (instead of the initial 37). Therefore, the target phoneme was identified and discriminated by 25 female (69.4%) and 11 male (30.6%) participants.

The identification task aimed at analysing the participants' ability to identify word-initial position /h/ in two sentence positions, namely in the middle of a sentence and at the end. On the whole, 144 stimuli were heard and categorized by each participant. Therefore, a total of 5184 identifications were included in the statistical analysis (144 sentences x 36 participants).

In order to verify whether the mean percentage of the variables (i.e. with /h/ and without /h/) differed significantly in the perception task, *t* tests were applied and their results are displayed in Table 12.

Table 12. *T* tests results of the Perception test

	Discrimination (n= 36) Mean (SD)	**Identification (n= 36) Mean (SD)**	**t (35)**
Total	70.74 (19.69)	88.54 (11.12)	7,100***
With /h/	71.09 (22.24)	89.58 (10.44)	6,518***
Without /h/	71.31 (19.16)	87.01 (14.33)	5,136***

Note. N= number of participants; SD= Standard Deviation; *t*= result of the *t* test; df= degrees of freedom; level of significance: *p< .05, ** p< .10, ***p< .001

[15] The term outlier refers to the values that are very different from the rest (Field, 2009)

[16] Detailed information on this participant will be described in section *3.4. Discussion* but the results will be presented at the end of section *3.2. Perception*.

As expected, the mean percentages obtained in both tests were significantly different ($p<.001$). The mean percentages of correct answers were higher in the identification test than the discrimination task, both in words with initial /h/ and words with initial vowels. The results revealed, generally speaking, that the L2 learners performed better at identifying the target sound than discriminating from words beginning with vowels.

By analysing the mean percentages separately (see Figure 21), it can be observed that the identification scored of both variables were rather close. Nevertheless, the participants obtained a higher percentage in identifying the words with the target phoneme (88.66%) than the words without /h/ (85.85%).

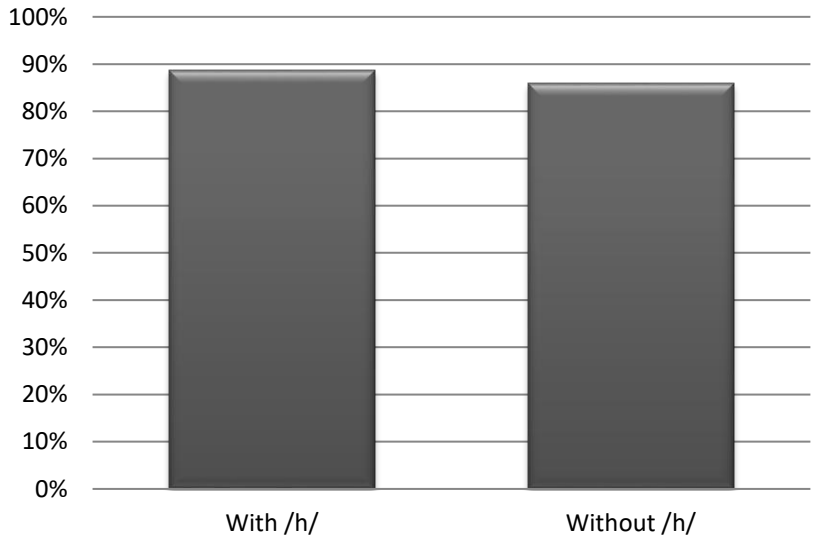


Figure 21. Mean percentage scores obtained in the ID task.

Similarly, the mean percentage of correct answers in the discrimination test was also close in both variables (see Figure 22). However, the trials in which the different token has a word without /h/ were better discriminated (70.14%) than those with /h/ (69.87%).

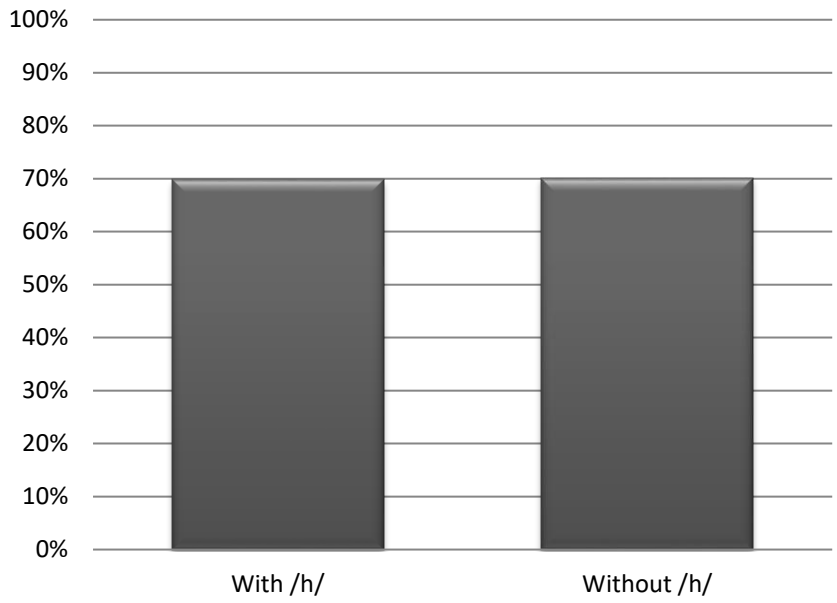


Figure 22. Mean percentage scores obtained in the DISC task.

Having reported the mean accurate percentage for each task and variable, we then compared the interval data of the perception tests in general. Figure 23 illustrates the total global scores of the participants in the identification and discrimination tasks.

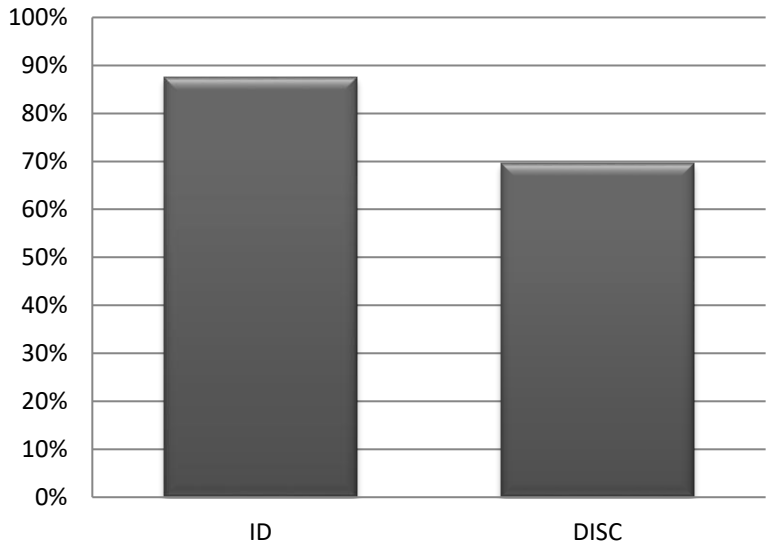


Figure 23. Total global scores of the Perception test.

As we can observe, L2 learners performed better in the identification task than in the discrimination task. We can conclude, then, that participants found the target phoneme easier to be identified than discriminated.

3.3 Production and Perception

A Pearson correlation coefficient test was computed to assess the relationship between production and perception performance of the L2 learners. The results of this test are presented in Table 13.

Table 13. Results of the Pearson Correlation Coefficient.

	DISC + P1 n=37 r	**DISC + P2 n=37 r**	**ID + P1 n=36 r**	**ID + P2 n=36 r**
With /h/	.39*	.56***	.35*	.32**
Without /h/	.45*	.26****	.56***	-.01****

Note. DISC= Discrimination test; ID= Identification test; P1= Word reading test; P2= Picture story description test; r= results of Pearson's correlation test; Level of significance: *p< .05, ** p< .10, ***p< .001, ****p>.05.

All correlation tests which included words with initial /h/ demonstrated that there was a significant positive correlation between the production and perception performance of the informants (p<.05). The results showed that higher accurate percentages of DISC and ID were associated with the correct production of /h/ in P1 (p<.05). Moreover, there was also an association between the discrimination test and the production of /h/ words in spontaneous speech (P2) but only a marginal significant correlation was found in the identification and production in P2 (p<.10).

Regarding the variable "without /h/", i.e. words with vowel-initial position, a positive correlation between the production and perception of these stimuli in P1 (p<.05) was also found. Therefore, higher percentages of accurate perception of these stimuli were associated with production in isolation. However, the production of words without /h/ in P2 was not correlated to

their perception (p>.05), which indicated that higher percentages of accurate productions of these words in P2 (i.e. spontaneous speech) were not associated with their accurate perception.

In sum, regarding words with /h/, L2 participants had worse performances in the picture story narration test and in the discrimination test.

Figure 24 shows the mean percentage scores of all four tests performed by the EFL learners.

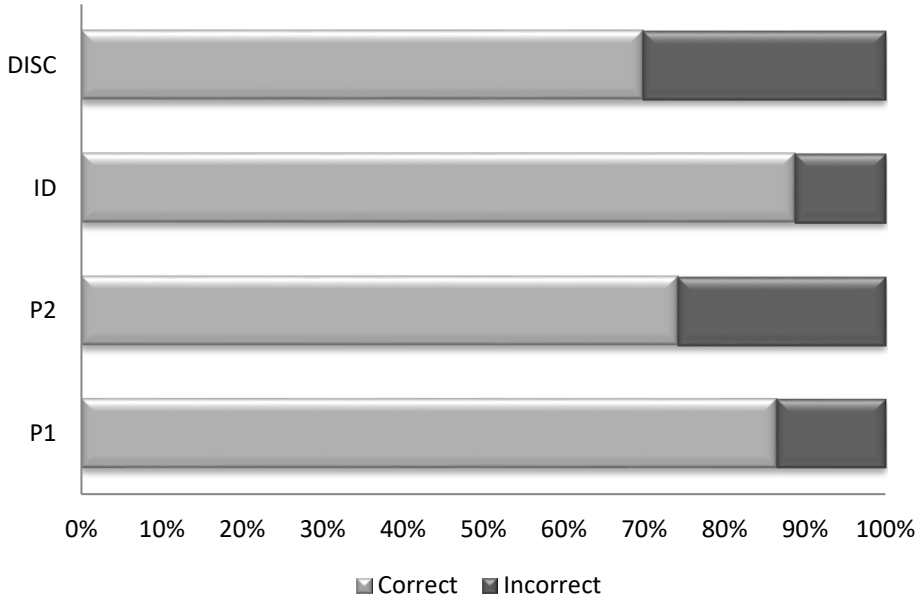


Figure 24. Mean percentages of all tests (words with /h/)

The graph demonstrates that participants reached higher scores in the production test 1 (P1) and in the identification test (ID), with only 13.63% of inaccurate productions and 11.34% of wrong answers, respectively. On the other hand, in the picture story narration test (P2), the target phoneme was inaccurately produced 25.86% while trials with /h/-initial words were wrongly discriminated 30.13%.

As aforementioned, when testing the normal distribution of the results in the ID task related to words without /h/, an outlier was revealed. This outlier was participant 15 who had a native-like performance which skewed the results.

Regarding the Production tests, in the word-reading task this participant obtained a mean accurate production of 95.83% in words with /h/ while in words without /h/, whose initial sound

was a vowel, the percentage was rather lower (4.17%). Contrarily, in the picture story narration task, the student obtained a higher score in words without /h/ (88.89%) than in words with the target phoneme (38.46%). By analysing the mean percentage of incorrect productions, we noticed that in the P1 test the outlier produced a mean score of 95.65% as far as insertion is concerned. The native-like results in P1, regarding words with the target phoneme in word-initial position, are justified by the high number of insertions. That is, words with /h/ in their initial position were produced accurately since this participant produced /instances of h-epenthesis frequently. On the other hand, words with /h/ were more inaccurately produced in P2 (38.46%) while words without /h/ obtained a higher mean percentage (88.89%) than in P1.

In the Perception test, the outlier had lower results than those of the Production tests. Concerning the ID task, the L2 learner scored a mean percentage of 55.56% in words with the target phoneme and 44.44% in those with a vowel-initial sound. Moreover, in the discrimination test the L2 learner also had low percentages: trials which contained /h/ had a mean score of 25.81% while those with an initial vowel were correctly discriminated 28.13%.

3.4 Discussion

The present study aimed at investigating whether: 1) advanced Portuguese EFL learners had acquired a "new" L2 phonetic category; 2) these FL learners were able to accurately discriminate and identify the target phoneme; 3) these learners produced the English phoneme /h/ correctly; 4) there was an effect of elicitation technique (word reading vs picture story narration) in the production of the target phoneme; and 5) there was a link between the production and perception abilities of Portuguese learners in the acquisition/learning of the target phoneme.

Firstly, the findings regarding the perceptual performance of the EFL learners are discussed. The identification and discrimination tests included natural stimuli (i.e. words beginning with /h/ and with vowels) recorded by three native speakers of British English. The perceptual experiment was conducted in a formal EFL classroom environment, namely within the *English Phonetics and Phonology 1* class at the University of Minho and all the participants were enrolled in a B2+ level English class, having acquired the level of B2 in February, 2016.

Based on the Speech Learning Model (Flege, 1987, 1995), it was predicted that the Portuguese native speakers would be able to accurately perceive the "new" L2 phonemic category as there is no "similar" sound in the L1 phonological system. Given the advanced level of English the participants had at the time of data collection, it was hypothesized that the perception of the target phoneme would not be difficult. The results partially confirmed this prediction given that the total ID and DISC scores were of 87.50% and 69.56%, respectively. The learners identified the target phoneme better than distinguished it, which suggests that they still have some difficulty in the perception of the target segment. A more detailed discussion of these results is provided next.

As far as identification is concerned, the mean accurate percentages demonstrate that there was almost no difference in identification of words with the target phoneme (86.66%) and words without /h/ (85.85%), that is, L2 listeners were able to identify both the realization and the omission of /h/. It was predicted that EFL learners would discriminate the target phonetic category better than identify it but this was not the case. Regarding the discrimination test, EFL learners were able to discriminate the English glottal fricative 69.87% and words without /h/ were also correctly discriminated with a mean percentage of 70.14%. On the one hand, the discrimination and identification tests had similar results as the mean correct percentages of both variables were very close. On the other hand, contrarily to the ID test, students obtained higher results at discriminating words without the target phoneme than those with /h/. Therefore, we concluded that this group of 37 native Portuguese speakers were better at identifying words with the target phoneme and discriminating words without /h/, contrarily to what was predicted.

Although some studies showed that EFL learners had better results at discriminating L2 sounds than identifying them (Flege, 1984; Best, McRoberts, & Goodbell, 2001; Best & Strange, 1992; Osborne, 2015), our findings revealed that the Portuguese EFL learners were better at identifying /h/ than discriminating it. Similar results were also found in the study of LaCharité and Prévost (cited in Archibald, 2005). The authors predicted that the acquisition the English glottal fricative would be rather difficult since it "requires the learner to posit a new articulator node, namely the Pharyngeal" (2005, p. 10). In order to confirm this prediction, LaCharité and Prévost conducted an experiment in which participants performed both a discrimination and an

identification task and their findings revealed that the discrimination of /h/ by Francophones was less accurate than identification.

The results of the current study revealed that the target phoneme was, to a great extent, accurately perceived (mean= 79.27%) but the L2 learners found /h/ more difficult to discriminate, which suggests that the phonemic category /h/ was not yet completely established, i.e. in a native-like manner. According to LaCharité and Prévost (2005) and John and Cardoso (2007), this difficulty may be due to the non-existence of the phoneme /h/ in romance languages, particularly in Portuguese and French. This perceptual difficulty may also be explained by the interference of L1 orthography on L2 speech perception, as reported by (Escudero & Wanrooij, 2010). Their findings reveal that perception of an L2 sound can be affected "when orthographic response options are available" (2010, p. 362), similarly to our design of the perception test.

Next, the findings of the production test are discussed. All students performed the production tests, which comprised a word-reading task (P1) and a picture story narration task (P2).

The production task aimed at investigating whether the EFL learners would be able to produce /h/ accurately in different contexts. Overall, the results confirmed that the informants produced the voiceless glottal fricative accurately with a mean percentage of 86.37% in P1 and 74.14% in P2. On the other hand, words with vowels in initial position obtained a mean percentage of 66.89% in P1 and 96.75% in P2. Generally speaking, there was a significant difference between the realization of /h/ in words in isolation and embedded in spontaneous speech, namely /h/ was accurately produced more frequently in P1, while the accurate production of words without /h/ obtained higher percentage in P2. A more detailed discussion on the production results will be presented next.

By taking into consideration the results of previous experiments (Oyama, 1976; Thompson, 1991), our hypothesis was that participants would produce the voiceless glottal fricative more inaccurately when embedded in words in isolation, i.e. EFL learners would produce more instances of foreign-accented speech in P1 than in P2, but this was not the case. As Figure 18 illustrates (see section 3.2 Production), participants produced more instances of foreign-accented speech in P2 (36.87%) than in P1 (30.80%). The fact that omission was the most

produced type of inaccurate realization of /h/ in P2 (64.89%), shows that the participants tended to produce this "new" L2 phonemic category as a result of orthographic interference between their L1 and L2. Similar findings on this significant interference were reported by Bassetii and Atkinson's study (2015) which revealed that orthographic interference had an effect on the production of L2 sounds by native Italian speakers of EFL. Moreover, the SLM hypothesizes that "some production difficulties may arise because features used in the L2 are not used in the L1" (Flege, 1995, p. 267) since the two phonological systems exist in a common phonological space, as is the case of /h/ in British English but not in European Portuguese. Therefore, more instances of omission occurred in spontaneous speech due to the inexistence of this phoneme in the phonological system of their L1 and the coexistence of the two phonological systems in a common phonological space.

Instances of h-epenthesis occurred more frequently in the P1 task with a mean percentage of 49.93% than in the picture story task. Contrarily to P2, the participants' speech was highly controlled in this test, which can also be considered more formal since participants might have felt the urge to perform well. Similar results were reported by John and Cardoso (2007), whose study focused on Francophone ESL learners. Their findings revealed that h-epenthesis tended to be produced "more frequently in more formal styles of speech" and "with a preceding vowel and a pause" (2007, p. 131). As abovementioned (see section 3.2.1.) not only did a vowel preceded the target phoneme, but a two second pause between each word in the P1 task was also included. As P1 was more controlled than P2, a more formal environment was established and EFL learners could have felt the pressure of producing a native-like performance. Thus, h-epenthesis was produced more often in P1 than in P2 as a result of the urge to produce /h/ like native English speakers.

In order to confirm if there was a correlation between production and perception, as showed by several studies (Sheldon & Strange, 1982; Flege & Eefting, 1987; Flege, 1993; Rochet, 1995; Kluge, Rauber, Reis, & Bion, 2007), Pearson's correlation tests were performed. The results of the tests revealed a positive correlation between the production and perception of /h/, namely that higher percentages in the perception test were associated with higher percentages in the production of /h/. Similarly to other L2 speech studies (Flege, 1995; Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004) we conclude that the accurate perception of /h/ was positively associated with its correct realization. In the cases in which there was some

difficulty in production, problems with perception may explain the deviations L2 learners produced as Flege describes that "without accurate perceptual 'targets' to guide the sensorimotor learning of L2 sounds, production of the L2 sounds will be inaccurate" (1995, p. 238). In other words, the author explains that faulty perception of a given L2 sound often results in faulty production of that sound. Moreover, Flege also states that "the production of a sound eventually corresponds to the properties represented in its phonetic category representation" (ibid, p. 239). The results of the perception test showed that the EFL learners were able to both accurately perceive the target phoneme with a mean percentage of 79.27% and produce it with a mean percentage of 80.26%. Generally speaking, the L2 participants were able to perceive and produce the target phoneme but with some difficulty, i.e. /h/ has not yet been completely established.

As aforementioned, participants reported an average AOL of 8 years old and a mean of 11 years of instruction. Therefore, it was expected that this group of learners would reach high scores when their ability to perceive and produce the English /h/ was tested. Moreover, as they are in daily contact with English because of both their classes in the degree in European Languages and Literatures and the exposure to English in TV entertainment and music, the participants had few difficulties regarding the pronunciation and perception of the target phoneme. However, it is important to notice that h-epenthesis was produced more frequently in P1 while h-deletion occurred more often in P2. Therefore, we conclude that L2 learners tend to produce instances of insertion in a more controlled context which may come as a result of the degree of formality of the task and the urge to perform well. Furthermore, instances of omission occurred more frequently in a semi-spontaneous context in which L2 learners' speech is expected to be as natural as possible. Consequently, h-deletion can be related to the lack of a non-existent aspiration feature of the target phoneme in their L1 inventory and its orthographic representation in European Portuguese.

CONCLUSION

The present study aimed at investigating the difficulties native Portuguese speakers of English as a foreign language (EFL) have when producing and perceiving the English phoneme /h/. More specifically, it examined how EFL learners produced the target phoneme in different contexts as well as their ability to distinguish and identify it. A brief summary of the results of the experiment is presented next by relating them to the research questions described in section 2.1. of the chapter Method.

By focusing on several studies carried out by Flege and his colleagues on second language speech acquisition (Flege, 1986; Flege & Eefting, 1987; Flege, MacKay & Fox, 1994; Flege & Schmidt, 1995; Flege, 1995a; Flege, MacKay & Meador, 1999; Flege & Liu, 1999, 2001; Piske, Flege and Schirru, 2001) and studies on the acquisition of /h/ by non-native speakers of English (LaCharité & Préstov, 1999; John & Cardoso, 2007; Osborne, 2015) the results of our experiment are summarized next in light of the research questions laid out above (see section 2.1.).

The results of the study demonstrate that Portuguese EFL advanced learners perceived the new L2 phoneme in a near-native-like manner (RQ1). The participants perceived the English /h/ with a mean percentage of 79.27%, proving that a new L2 phonetic category was established, at least for the majority of the learners. The target phoneme was not identified only 20.73% of the time. Due to this fact, we conclude that Portuguese EFL advanced learners were able to recognize the phonetic features involved in the realization of English /h/, thus establishing a new phonemic category in their L2 inventory. Even though the participants were able to perceive the new sound, the data of the perception test revealed that the target phoneme was better identified than discriminated (RQ4), contrarily to what was expected. This means that Portuguese advanced leaners still have some difficulty in perceiving the occurrence of aspiration which may indicate that their L1 and L2 phonetic systems interact with each other (Grosjean, 1989; Flege, Schirru, & MacKay, 2003) in a common phonological space (Flege, 1995). Furthermore, orthographic interference has also previously proved to be crucial when perceiving L2 sounds (Escudero & Wanrooij, 2010; Bassetti and Atkinson, 2015).

As far as RQ2 is concerned, the results revealed that there was little difficulty in producing the voiceless glottal fricative, as predicted. By relating these results to the descriptive analysis of

the participants' questionnaires, we conclude that factors such as AOL along and quantity and quality of L2 input play an important role in the accurate production of this new sound. The group of EFL advanced learners reported having daily contact with English, as most of their classes are taught in English and entertainment activities are almost exclusively produced/ broadcast in English (e.g.: music, TV shows, movies). As a result, the target phoneme was accurately produced 76.63% of the time. Nevertheless, data from both production tests (P1 and P2) were quite different regarding the production of /h/ which suggests that there was an effect of elicitation technique (RQ3). Based on previous research (Oyama, 1976; Thompson, 1991), it was hypothesized that participants would produce more foreign-accented productions, that is, more deviations from the English phonetic realizations, in the word reading test (P1). However, the 37 participants misproduced /h/ more frequently in the story narration task (P2) (36.87%) than in P1 (30.80%). Therefore, we conclude that accurate production of /h/ is better promoted in word-reading tasks, in which words are presented in isolation and in a controlled context, than in semi-spontaneous speech, in which words are elicited more naturally in picture story telling.

A link between the production and perception of /h/ was also found (RQ5). Perception of the target phoneme has proved to be correlated with its production, but not to the same extent. The EFL learners obtained marginally higher scores in the perception of the target phoneme (80.26%) than in its production (79.27%). Therefore, these two speech domains are linked due to the fact that their results are so close and a significant difference was not found. Furthermore, Pearson's coefficient proves that a high percentage in the perception of /h/ is associated with a high percentage of accurate productions of this new sound. For this reason, we conclude that improvements on the perception of /h/ will lead to its accurate, native-like production.

This study could be furthered by including a comparison between the performance of late and early learners of EFL in order to verify if the new sound is in fact more accurately perceived and produced as AOL increases. Moreover, our results show that L2 learners tended to produce instances of /h/ in the middle of the word <hyena> which often resulted in the production of [haɪˈ**h**i:nə] and sometimes [aɪˈ**h**i:nə]. This latter example is a curious finding in which participants tended to dislocate /h/ from the beginning to the middle of the word. This process of h-dislocation was only verified in this specific word but future research should include other stimuli and investigate this process.

Due to the scarcity of research on the acquisition of /h/ by non-native speakers of English, namely those whose L1 is a Romance language, our results could not be compared to other findings. Similarly to other findings (John and Cardoso, 2007; Osborne, 2015), our results show that L2 learners tend to produce instances of h-epenthesis in a more controlled, formal environment and when the target phoneme precedes a vowel and a pause. Moreover, Osborne (20015) revealed that L2 proficient learners perceived the English /h/ accurately and that "L1 orthographic knowledge can have an effect on both perception and production of a second language" (2015, p. 176).

We believe this study on the acquisition of /h/, a non-existent sound in the Portuguese phonological system is, to some extent, novel. Besides the fact that there have not been many studies focusing on the acquisition of this particular sound, we believe that our findings contribute to the L2 speech learning by focusing on the production and perception of a new L2 sound. Moreover, the study has raised awareness to the production of /h/ by the participants, particularly the importance of its accurate production when speaking to a NES (e.g.: I ate apples vs. I [h]ate apples), i.e. its effect on how they (i.e. participants) are perceived by the others, that is, to be certain that their intelligibility is not compromised and that their speech is clearly understood.

In sum, the present study has shown that native Portuguese speakers of EFL both produced and perceived the target phoneme with little difficulty. Nevertheless, a better performance in the perception of /h/ was associated with its accurate production, that is, if L2 learners were able to perceive the occurrence of an aspirated /h/, it was more likely that they would produce the target phoneme more accurately. Furthermore, instances of h-insertion were mostly associated with the degree of formality of the task and h-deletion may be regarded as a consequence of the fact that both L1 and L2 exist in a common phonological space, in which /h/ is sometimes not produced at all (as it occurs in the L1) and/or produced according to its L2 phonemic norm.

BIBLIOGRAPHY

Aoyama, K., Flege, J. E., Guion, S. G., Akahane-Yamada, R., & Yamada, T. (2004). Perceived phonetic dissimilarity and L2 speech learning: the case of Japanese /r/ and English /l/ and /r/. *Journal of Phonetics, 32*, 233-250.

Archibald, J. (2005). Second Language Phonology as Redeployment of Phonological Knowledge. *Canadian Journal of Linguistics, 50*, 285-314.

Azevedo, M. M. (1981). Comparison of Phonological Units. In M. M. Azevedo, *A Contrastive Phonology of Portuguese and English* (pp. 57-74). Georgetown University Press.

Barroso, H. (1999). *Forma e Substância da Expressão da Língua Portuguesa.* Coimbra: Livraria Almedina.

Bassetti, B. (2008). Orthographic input and second language phonology. In T. Piske, & M. Young-Scholten, *Input matters in SLA* (pp. 191-206). Multilingual Matters.

Bassetti, B., & Atkinson, N. (2015). Effects of orthographic forms on pronunciation in experienced instructed second language learners. *Applied Psycholinguistics, 36(1)*, 67-91.

Best, C. T., & Strange, W. (1992). Effects of Phonological and Phonetic Factors on Crosslanguage Perception of Approximants. *Journal of Phonetics*, 89-108.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception. In O.-S. Bohn, & M. J. Munro, *Language Experience in Second Language Speech Learning: In honor of James Emil Flege* (pp. 13-45). Amsterdam/ Philadephia: John Benjamins Publishing Company.

Best, C. T., McRoberts, G. W., & Goodbell, E. (2001). Discrimination of non-native consonant contrasts varying in perceptual assimilation to the listener's native phonological system. *Journal of the Acoustical Soceity of America*, 775–794.

Best, C. T., McRoberts, G. W., & Sithole, N. M. (1987). *Examination of Perceptual Reorganization for Nonnative Speech Contrasts: Zulu Click Discrimination by English-Speaking Adults and Infants.* Haskins Laboratories.

Bohn, O.-S., & Flege, J. E. (1990). Interlingual identification and the role of foreign language experience in L2 vowel perception. *Applied Psycholinguistics*, 303-328.

Bongaerts, T., Summeren, C. v., Planken, B., & Schills, E. (1997). Age and the Ultimate Attainment in the Pronunciation of a Foreign Language. *Studies in Second Language Acquisition*, 447-465.

Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR). (2001). Retrieved from: http://www.coe.int/t/dg4/linguistic/cadre1_en.asp

Derwing, T. M., & Munro, M. J. (2009). Putting accent in its place: Rethinking obstacles to communication. *Language Teaching*, 476-490.

Eimas, P. D. (1974). Auditory and linguistic processing of cues for place of articulation by infants. *Doctoral dissertation*.

Eimas, P. D., Siqueland, E. E., Jusczyk, P., & Vigorito, J. (22 de January de 1971). Speech Perception in Infants. pp. 303-306.

Escudero, P. (2005). Linguistic Perception and Second Language Acquisition: Explaining the attainment of optimal phonological categorization. *Doctoral Dissertation*, pp. 155-202.

Escudero, P., & Wanrooij, K. (2010). The Effect of L1 Orthography on Non-native Vowel Perception. *Language and Speech, 53 (3)*, 343-365.

Fayer, J. M., & Krasinski, E. (1987). Native and Nonnative Judgments of Intelligibility and Irritation. *Language Learning, v. 37*, 313–326.

Field, A. (2009). *Discovering Statistics using SPSS.* India: SAGE Publications.

Flege, J. E. (1981). The phonological basis of foreign accent. *TESOL Quarterly*, 443-455.

Flege, J. E. (1984). The effect of linguistic experience on Arabs' perception of the English /s/ vs. /z/ contrast. *Folia Linguistica, 18*, 117-138.

Flege, J. E. (1987). The production of "new" and "similar" phones in a foreign language: evidence for the effect of equivalence classification. *Journal of Phonetics*, 47-65.

Flege, J. E. (1991). Age of learning affects the authenticity of voice-onset time (VOT) in stop consonants produced in a second language. *Journal of the Acoustical Society of America*, 395-411.

Flege, J. E. (1992a). The intelligibility of English vowels spoken by British and Dutch talkers. In R. D. Kent, *Intellibility in Speech Disorders* (pp. 157-232). Amsterdam: John Benjamins.

Flege, J. E. (1993). Production and perception of a novel, second-language phonetic contrast. *Journal of the Acoustical Society of America*, 1589-1608.

Flege, J. E. (1995). Second Language Speech Learning: Theory, Findings and Problems. In W. Strange, *Speech Perception and Linguistic Experience: Issues in Cross-Language Research* (pp. 233-277). Timounium, MD: York Press.

Flege, J. E. (1999). Age of Learning and Second Language Speech. In D. Birdsong, *SecondLanguage Acquisition and the Critical Period Hypothesis* (pp. 101-131). New Jersey: Lawrence Earlbaum Associates.

Flege, J. E. (2005). *Origins and development of the Speech Learning Model.* Retrieved from: http://jimflege.com/files/Vancouver_April_2005.pdf

Flege, J. E., & Eefting, W. (1987). The production and perception of English stops by native Spanish speakers. *Journal of Phonetics*, 67-83.

Flege, J. E., & Fletcher, K. L. (1992). Talker and listener effects on degree of perceived foreign accent . *Journal of the Acoustical Society of America*, 370-389.

Flege, J. E., & Fox, R. A. (1994). Auditory and categorical effects on cross-language vowel perception. *Journal of the Acoustical Society of America*, 3623-3641.

Flege, J. E., & Hillenbrand, J. (1984). Limits on phonetic accurary in foreign language speech production. *Journal of the Acoustical Society of America*, 708-720.

Flege, J. E., & Liu, S. (2001). The effect of experience on adults' acquisition of a second language. *Studies in Second Language Acquisition*, 527-552.

Flege, J. E., & MacKay, I. R. (2002). Assessing bilingual dominance. *Applied Psycholinguistics*, 567-598.

Flege, J. E., & MacKay, I. R. (2004). Effects of the age of second language acquisition on the duration of first and second language sentences: The role of suppresion. *Applied Psycholinguistics, 25*, 373-396.

Flege, J. E., & Meador, D. (1999). Native Italian speakers' production and perception of English vowels. *Journal of the Acoustical Society of America*, 2973-2987.

Flege, J. E., & Nozawa, T. (1997). Amount of native-language (L1) use affects the pronunciation of an L2. *Journal of Phonetics*, 169-186.

Flege, J. E., & Schmidt, A. M. (1995). Native Speakers of Spanish Show Rate-Dependent Processing of English Stop Consonants. *Phonetica*, 90-111.

Flege, J. E., Munro, M. J., & MacKay, I. R. (1995b). Effects of age of second language learning on the production of English consonants. *Speech Communication*, 1-26.

Flege, J. E., Schirru, C., & MacKay, I. R. (2003). Interaction between the native and second language phonetic subsystems. *Speech Communication*, 467-491.

Flege, J. E., Yeni-Komshian, G., & Liu, S. (1999). Age Constraints on Second-Language Acquisition. *Journal of Memory and Language*, 78-104.

Giles, H. (1970). Evaluative Reactions to Accents. *Educational Review, 22 (3)*, 211-227.

Giles, H., Coupland, N., & Coupland, J. (1991). *Contexts of accomodation: Developments in Applied Sociolinguistics.* Cambridge: Cambridge University Press.

Giles, H., Willemyns, M., Gallois, C., & Chernikoff, A. M. (2007). Accommodating a new frontier: the context of law enforcement. pp. 129-162.

Godenzzi, J. C. (2006). Spanish as Lingua Franca. *Annual Review ofApplied Linguistics, v. 26*, 100-124.

Gozalo-Llera, C. (2011). The Aspiration of the Spanish Grapheme "h". *Research and Creative Activities poster day. Paper 2*.

Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Brain and Language, 36*, 3-15.

Gumperz, J. J. (1970). *Discourse Strategies.* Cambridge University Press.

Holden, K., & Hogan, J. (1993). The emotive impact of foreign intonation: an experiment in switching English and Russian intonation. *Language and Speech, v. 36*, 67-88.

Janda, R. D., & Auger, J. (1992). Quantitative evidence, qualitative hypercorrection, sociolinguistic variables - and French speaker's 'eadaches with English /h/. *Language and Communication*, 195-236.

Jia, G., Strange, W., Wu, Y., & Collado, J. a. (2006). Perception and Production of English Vowels by Mandarin Speakers: Age-related differences vary with amount of L2 exposure. *Journal of the Acoustical Society of America*.

John, P., & Cardoso, W. (2007). Francophone ESL Learners' Difficulties with English /h/. *New Sounds 2007: Proceedings of the Fifth International Symposium on the Acquisition of Second Language Speech* , (pp. 259-273).

Johnson, J. S., & Newport, E. L. (1989). Critical Period Effects in Second Language Learning: The Influence of Maturational State on the Acquisition of English as a Second Language . *Cognitive Psychology*, 60-99.

Kluge, D. K., Rauber, A. S., Reis, M. S., & Bion, R. A. (2007). The Relationship between the Perception and Production of English Nasal Codas by Brazilian Learners of English. *Interspeech*, (pp. 2297-2300). Florianópolis, Brazil .

Koerich, R. D. (2002). Perception and Production of word-final vowel epenthesis by Brazilian EFL students. *Doctoral Dissertation*. Florianópolis, Brazil.

LaCharité, D., & Prévost, P. (1999). Le rôle de la langue maternelle et de l'eseignment dans l'a acquisition des segments de l'anglais langue seconde par des apprenants francophones. *Langues et Linguistique, 25*, 81-109.

Ladefoged, P. (1967). *Three areas of experimental phonetics.* London: Oxford University Press.

Lambert, W. E., Hodgson, R. C., Gardner, R. C., & Fillenbaum, S. (1960). Evaluational reactions to spoken languages. *The Journal of Abnormal and Social Psychology, v. 60*, 44-51.

Lane, H. (1963). Foreign Accent and Speech Distortion. *Acoustical Society of America*, 451-453.

Lane, L. (2012). *Focus on Pronunciation3.* Pearson Education.

Lenneberg, E. H. (1967). *Biological Foundations of Language.* New York: John Willey & Sons.

Lev-Ari, Shiri, & Keysar, B. (2010). Why don't we believe non-native speakers? The influence of accent on credibility. *Journal of Experimental Social Psychology*, 1093-1096.

Levelt, W. J. (1989). *Speaking: From intention to articulation.* Cambridge: MIT Press.

Levelt, W., Roelofs, A., & Meyer, A. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 1-75.

Liberman, A. M., & Mattingly, I. G. (1985). The motor thoery of speech perception revised. *Cognition*, 1-36.

Liberman, P., & Blumstein, S. E. (1998). *Speech Physiology, Speech Perception and Acoustic Phonetics.* Cambridge: Cambridge University Press.

Lippi-Green, R. (1997). *English with an Accent: Language, ideology and discrimination in the United States.* London: Routledge.

Lively, S. E., Logan, J. S., & Pisoni, D. J. (1993). Training Japanese listeners to identify English /r/ and /l/: II. The role of phonetic environment and talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America*, 1242–1255.

Logan, J. S., & Pruit, J. S. (1995). Methodological issues in training listeners to perceive non-native phonemes. In W. Strange, *Speech Perception and Linguistic Experience: Theoretical and Methodological Issues in Cross-Language Speech Research* (pp. 351-377).

MacKay, I. R., Flege, J. E., Piske, T., & Schirru, C. (2001). Category restructuring during second-language (L2) speech acquisition. *Journal of the Acoustical Society of America*, 516-528.

Martins, C. (2011). *Manual de Análise de Dados Quantitativos com recurso ao IBM SPSS: Saber decidir, fazer, interpretar e redigir.* Braga: Edições Psiquilíbrios.

McLaughlin, B. (1977). Second-language learning in children. *Psychological Bulletin*, 438-459.

Mompean, J. A., & Fouz-González, J. (2015). *Investigating English Pronunciation: Trends and Directions.* Palgrave MacMillan.

Moyer, A. (2013). *Foreign Accent: The Phenomenon of Non-native Speech.* Cambridge: Cambridge University Press.

Munro, M. J., & Bohn, O.-S. (2007). *Language Experience in Second Language Speech Learning - In honor of James Emil Flege .* Amsterdam, Philadelphia: John Benjamins Publishing Company.

Neveďalová, K. (2013). *Report on Rethinking Education.* European Parliament.

Osborne, D. (2015). The L2 perception of initial /h/ and /r/ by Brazilian Portuguese learners of English. *Journal of Second Language Pronunciation*, 157-180.

Oyama, S. (1976). A sensitive period for the acquisition of a nonnative phonological system. *Journal of Psycholinguistic Research, volume 5*, 261-283.

Pak, J. (2012). *Is English or Mandarin the language of the future?* Retrieved from: http://www.bbc.com/news/magazine-17105569

Penfield, W. (1965). Conditioning the uncommitted cortex for language learning. *Brain, Oxford Journal*, 787-798.

Piske, T. (2007). Implications of James E. Flege's research for the foreign language classroom. In O.-S. Bohn, & M. J. Munro, *Language Experience in Second Language Speech Learning - In honor of James Emil Flege* (pp. 301-314). Amsterdam/ Philadelphia: John Benjamins Publishing Company.

Piske, T. F., MacKay, I. R., & Meador, D. (2002). The Production of English Vowels by Fluent Early and Late Italian-English Bilinguals. *Phonetica*, 49-71.

Piske, T., MacKay, I., & Flege, J. E. (2001). Factors affecting degree of foreign accent in an L2: A review. *Journal of Phonetics*, 191-215.

Pisoni, D. B., & Lively, S. E. (1995). Variability and Invariance in Speech Perception: A New Look at Some Old Problems in Perceptual Learning. In W. Strange, *Speech Perception and Linsguistic Experience: Issues in Cross-Language Research* (pp. 433-459). Timonium, Md: York Press.

Rato, A. (2013). Cross-language Perception and Production of English Vowels by Portuguese Learners: The Effects of Perceptual Training. *Doctoral Dissertation*.

Reetz, H., & Jongman, A. (2009). *Phonetics: Transcription, Production, Acoustics and Perception.* United Kingdom: Wiley-Blackwell Publishing.

Reis, M. S. (2010). The Perception and Production of the English voiceless interdental fricative /θ/ by speakers of European French and Brazilian Portuguese. *Doctoral Dissertation*. Florianópolis, Brazil.

Rochet, B. L. (1995). Perception and Production of Second-Language Speech Sounds by Adults. In W. Strange, *Speech Perception and Linguistic Experience: Theoretical and Methodological Issues in Cross-Language Speech Research* (pp. 379-410). York Press.

Rubio, F. D., & Lirola, M. M. (2010). English as a foreign language in the EU - Preliminary analysis of the difference in proficiency levels among the member states. *European Journal of Language Policy, 2 (1)*, 23-39.

Sapon, S. (1952). An application of psychological theory to pronunciation problems in second language learnin. *Modern Language Journal*, 111-114.

Sheldon, A., & Strange, A. (1982). The acquisition of /r/ and /l/ by Japanese learners of English: Evidence that speech production can precede speech perception. *Applied Psycholinguistics*, 243-261.

Sim-Sim, I. (1998). *O Desenvolvimento da Linguagem.* Lisboa: Universidade Aberta.

Sim-Sim, I., Silva, A. C., & Nunes, C. (2008). *Linguagem e Comunicação no Jardim-de-Infância: Textos de Apoio para Educadores de Infância.* Lisboa: Ministério da Educação & Direcção-Geral de Inovação e de Desenvolvimento Curricular.

Singleton, D., & Lengyel, Z. (1995). *The Age Factor in Second Language Acquisition: A Critical Look at the Cirtical Period Hypothesis.* Multilingual Matters Ltd.

Strange, W. (1992). Learning non-native phoneme contrasts: Interactios among subject, stimulus, and task variables. In Y. Tohkura, E. Vatikiotis-Bateson, & Y. Sagisaka, *Speech Perception, Production and Linguistic Structure* (pp. 197-209). IOS Press.

Strange, W. (1995). *Speech Perception and Linguistic Experience: Theoretical and Methodological Issues in Cross-Language Speech Research.*

Strecht-Ribeiro, O. (2005). *A Língua Inglesa no 1º Ciclo do Ensino Básico.* Livros Horizonte.

Thompson, I. (1991). Foreign Accents Revisited: The English Pronunciation of Russian Immigrants. *Language LEarning, v. 41*, 177-204.

Trubetzkoy, N. (1969). *Principles of Phonology.* Retrieved from: https://monoskop.org/images/7/73/Trubetzkoy_NS_Principles_of_Phonology.pdf

Software:

Audacity (v. 2.0.2). Retrieved from https://sourceforge.net/projects/audacity/?lang=pt

Boersma, P., & Weenink, D. (2014). *Praat: doing phonetics by computer (v. 5.3.39).* Retrieved from: http://www.fon.hum.uva.nl/praat/download_win.html

Rauber, A., Rato, A., Kluge, D., & Santos, G. (2012). *TP, v. 3.1.* Retrieved from: http://www.worken.com.br/tp_regfree.php

ANNEXES

Annex A

Calendar

Data collection – Production test.

Time	Tuesday, May 17 (?)	Wednesday, May 18	Thursday, May 19	Friday, May 20
9h				
9h30				
10h				
10h30				
11h				
11h30				
12h				
12h30				
13h				
13h30				
14h				
14h30				
15h				
15h30				
16h				
16h30				
17h				
17h30				
18h				
18h30				

Data collection – Production test.

Time	Monday, May 23	Tuesday, May 24 (PERCEPTION TEST)	Wednesday, May 25	Thursday, May 26	Friday, May 27
9h					
9h30					
10h					
10h30					
11h					
11h30					
12h					
12h30					
13h					
13h30					
14h					
14h30					
15h					
15h30					
16h					
16h30					
17h					
17h30					
18h					
18h30					

Annex B

Background questionnaire for L1 participants

Questionnaire

Name: _____

Age: _____ **Gender:** _____

Native language: _____

Occupation: _____

How long have you been living in Portugal?

_____

How often do you use Portuguese per week? (Number of hours)

_____

How long did you live in the United Kingdom?

_____

Other countries that you have lived in and the duration

_____

_____

When did you start learning English?

_____

Do you use English on an everyday basis?

_____

Thank you very much for your participation

Annex C

Background questionnaire for L2 participants

Questionnaire

Name: _____

Email: _____ _____

Phone number (optional): _____

Age: _____ Date and place (city/country) of birth: _____

Undergraduate course: _____ Year: _____

1. Is European Portuguese your mother tongue? No ☐ Yes ☐
2. Do you speak any other language at home? No ☐ Yes ☐
   a. Which one(s)? _____
   b. Did you learn it before the age of 6? No ☐ Yes ☐
3. Are your parents native speakers of European Portuguese? No ☐ Yes ☐
   a. Which native language(s) do your parents speak?

   _____
4. Have you ever lived abroad (more than 3 months)? Yes ☐ No ☐
   a. In which country? _____
   b. How long did you live there? _____
   c. Did you speak English? No ☐ Yes ☐
   d. How often? (average number of hours per day)

15 – 30 min/day ☐ 20 – 40 min/day ☐ 1h – 2h/day ☐ More than 2h/day ☐

   e. How old were you? _____
5. Have you ever lived in an English speaking country? No ☐ Yes ☐
   a. Which one(s)? _____
   b. How often did you use English? (number of hours per day)

15 – 30 min/day ☐ 20 – 40 min/day ☐ 1h – 2h/day ☐ More than 2h/day ☐

   c. How long did you live there? _____
   d. How old were you? _____

6. Please, provide information about the foreign languages you know

Language	**Level of Proficiency**						**Age of learning**	**Years of instruction**	**Place of instruction** (e.g. private language school, public school, etc)
	Beginner		**Intermediate**		**Advanced**				
	A1	**A2**	**B1**	**B2**	**C1**	**C2**			

7. From **1** (**poor**) to **10** (**excellent**), what's your oral comprehension (i.e., listening) level in English? (Circle the number)

1 2 3 4 5 6 7 8 9 10

8. From **1** to **10**, what's your oral production (i.e., speaking) level in English?

1 2 3 4 5 6 7 8 9 10

9. Do you speak English outside the classroom? Yes ☐ No ☐
   a. How often? (number of hours per day):

15 – 30 min/day ☐ 20 – 40 min/day ☐ 1h – 2h/day ☐ More than 2h/day ☐

10. Do you watch TV shows or movies in English? Yes ☐ No ☐
    a. How often? (number of hours per day)

15 – 30 min/day ☐ 20 – 40 min/day ☐ 1h – 2h/day ☐ More than 2h/day ☐

b. Do you normally use subtitles? Yes ☐ No ☐

i. If yes, in what language(s)? _____

11. Do you listen to music in English? Yes ☐ No ☐

a. How often? (number of hours per day):

15 – 30 min/day ☐ 20 – 40 min/day ☐ 1h – 2h/day ☐ More than 2h/day ☐

12. Do you play games in English? Yes ☐ No ☐

a. How often?

15 – 30 min/ day ☐ 20 – 40 min/ day ☐ 1h – 2h/day ☐ More than 2h/ day ☐

13. Do you have a speaking and/or hearing impediment? Yes ☐ No ☐

(Specify which): _____

14. Add any other relevant information about your language background (optional)

_____

_____

_____

By signing, I agree to participate in this research:

_____ _____

(Signature) (Date)

Thank you very much for your participation.

Annex D

Summary of the statistical descriptive data of the background questionnaire

(L2 participants)

	Mean (years)	*SD*	Range (years)
Age	19.24	1.321	18-22
AOL	8.06	1.613	5-11
LFI	10.85	1.726	8-15

Note: AOL= Age of learning; LFI= Length of formal instruction; SD= Standard Deviation.

	Values (%)		
	M	F	*Mo*
Sex	29.7	70.3	1

Note: M= Male; F= Female; M= Mode.

	Cumulative percent		
	Mdn	(%)	Label
English proficiency	2	78.4	B2
Place of instruction	1	97.1	Public School

Note: Mdn= Median.

	Values (%)		Mo
	Yes	No	
English use			
Outside the classroom	91.9	8.1	1
Watch TV shows/movies	100	0	1
Music	100	0	1
Games	56.8	43.2	1
Speaking/ Hearing impediment	0	100	2

Note: Mo= Mode.

	Cumulative Percent		
	Mdn	(%)	Label
English use			
Outside the classroom	2	67.6	20-40m/day
Watch TV shows/movies	3	83.8	1h-2h/day
Music	4	100	More than 2h/day
Games	4	51.4	More than 2h/day

Note: Mdn= Median.

	Values (%)		Mo
	Yes	No	
L1 background			
EP as their L1	100	0	2
Other languages spoken at home	13.5	86.5	1
Parents' L1 is EP	91.9	8.1	2

Note: L1= Native language; EP= European Portuguese; Mo= Mode.

Annex E

List of words used in the word-reading task (P1)

	With /h/	Without /h/
Familiarization test	Hamburgers	Orange
	Hawk	Europe
	Hotdogs	
Test	Hair	Iphone
	Halloween	Ear
	Hamster	Old man
	Hat	Art
	Heart	Earth
	Hit	Arrow
	Holidays	Ice cream
	Honey	Oven
	Horse	Island
	Hospital	Unicorn
	Hotel	Up
	House	Umbrella
	Heavy	Arm
	Hungry	Ankle
	Hyena	Apple
	Hallways	Elbow
	High-heel	Ice
	Helicopter	Ashes
	Hockey	Elephants
	Hanger	Ill
	Hammer	Onion
	Horoscope	Owl
	Hug	Oyster
	Host	University

Annex F

Images used in the word-reading task 1

1. Familiarization test

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

2. Test

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
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I say *word*
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I say *word*
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I say *word*
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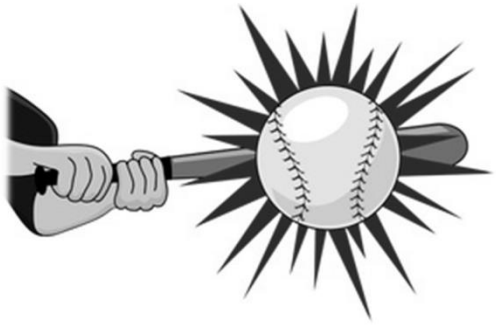
word
I say *word*
word



word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
word

word
I say *word*
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I say *word*
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I say *word*
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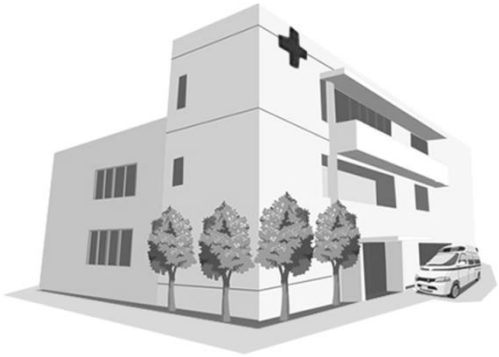
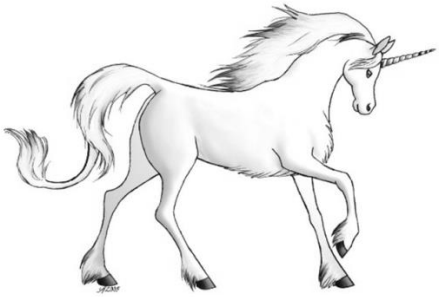


word
I say *word*
word



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I say *word*
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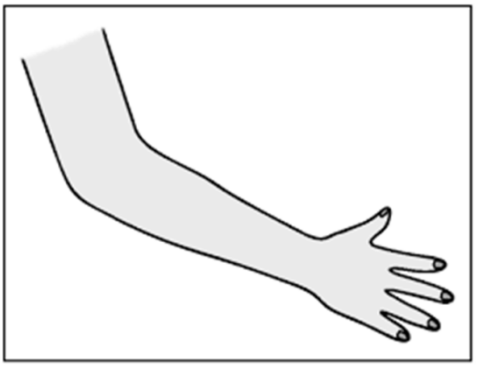

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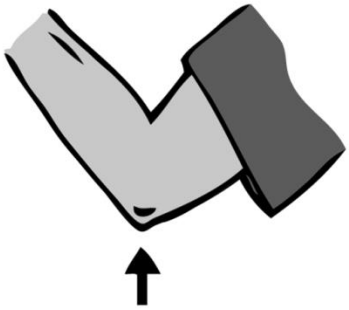

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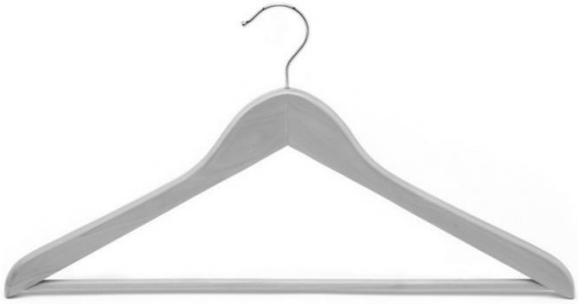

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I say *word*
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I say *word*
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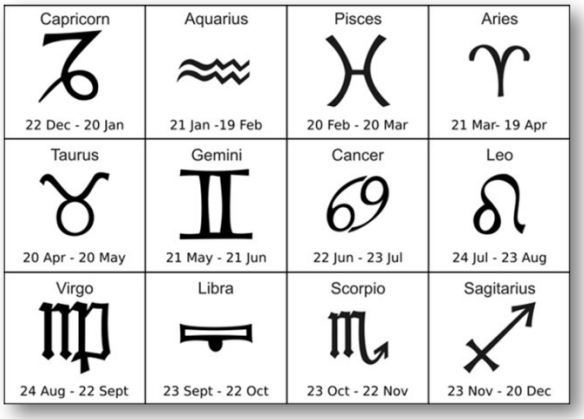

word
I say *word*
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I say *word*
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I say *word*
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I say *word*
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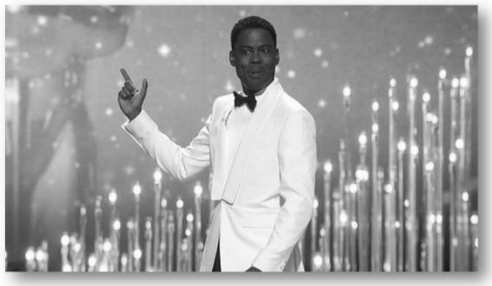
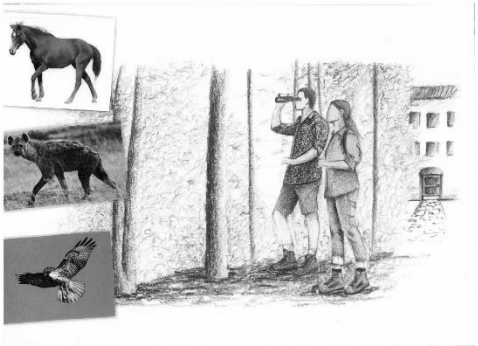
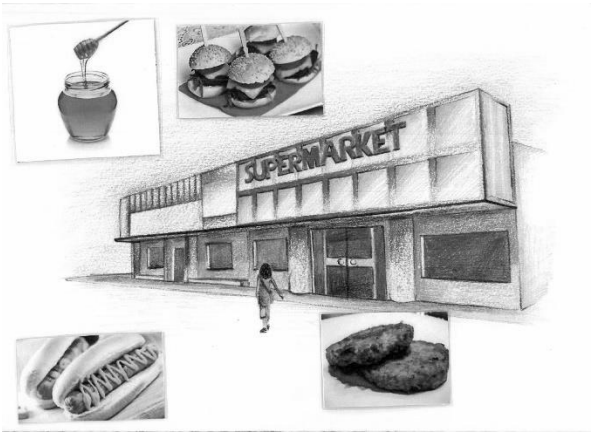


word
I say *word*
word

Annex G

Drawings used in the narrative production task (P2)





Annex H

Stimuli organization of the oddity discrimination task

1. Familiarization test

Change trials	Catch trials	Change trials
M1_had; F1_ad; M2_ad	**F1_had; M1_had; M2_had**	**F1_ad**; M2_had; M1_had
F1_ad; **M2_had**; M1_ad	**M1_ad; F1_ad; M2_ad**	M1_had; **M2_ad**; F1_had
M2_ad; F1_ad; **M1_had**		M2_had; F1_had; **M1_ad**

2. Test

Change trials	Catch trials	Change trials
F1_hail; M1_ail; M2_ail	**F1_hail**; **M1_hail**; **M2_hail**	**F1_ail**; M2_hail; M1_hail
M1_ail; **M2_hail**; F1_ail	**M1_ail**; **F1_ail**; **M2_ail**	M1_hail; **M2_ail**; F1_hail
M2_ail; F1_ail; **M1_hail**		M2_hail; F1_hail; **M1_ail**
M2_hair; M1_air; F1_air	**M1_hair**; **F1_hair**; **M2_hair**	**F1_air**; M2_hair; M1_hair
M1_air; **F1_hair**; M2_air	**M2_air**; **M1_air**; **F1_air**	M2_hair; **M1_air**; F1_hair
F1_air; M2_air; **M1_hair**		M1_hair; F1_hair; **M2_air**
M1_hallways; F1_always; M2_always	**F1_hallways**; **M1_hallways**; **M2_hallways**	**F1_always**; M2_hallways; M1_ hallways
F1_always; **M2_hallways**; M1_always	**M1_always; F1_always; M2_always**	M1_hallways; **M2_always**; F1_hallways
M2_always; M1_always; **F1_hallways**		M2_hallways; F1_hallways; **M1_always**
F1_handy; M1_andy; M2_andy	**F1_handy**; **M1_handy**; **M2_handy**	**F1_andy**; M2_handy; M1_handy
M1_andy ; **M2_handy**; F1_andy	**M1_andy**; **F1_andy**; **M2_andy**	M1_handy; **M2_andy**; F1_handy
M2_andy; F1_andy; **M1_handy**		M2_handy; F1_handy; **M1_andy**
M2_hanger; M1_anger; F1_anger	**M1_hanger**; **F1_hanger**; **M2_hanger**	**F1_anger**; M2_hanger; M1_hanger
M1_anger**; F1_hanger**; M2_anger	**M2_anger**; **M1_anger**; **F1_anger**	M2_hanger**; M1_anger**; F1_hanger
F1_anger; M2_anger; **M1_hanger**		M1_hanger; F1_hanger; **M2_anger**
M2_harrow; M1_arrow; F1_arrow	**M1_harrow**; **F1_harrow**; **M2_harrow**	**F1_arrow**; M2_harrow; M1_harrow
M1_arrow; **F1_harrow**; M2_arrow	**M2_arrow**; **M1_arrow**; **F1_arrow**	M2_harrow; **M1_arrow**; F1_harrow
F1_arrow; M2_arrow; **M1_harrow**		M1_harrow; F1_harrow; **M2_arrow**

Change trials	Catch trials	Change trials
M1_hash; F1_ash; M2_ash F1_ash; **M2_hash**; M1_ash M2_ash; M1_ash; **F1_hash**	**F1_hash**; **M2_hash**; **M1_hash** **M1_ash**; **F1_ash**; **M2_ash**	**F1_ash**; M2_hash; M1_hash M1_hash; **M2_ash**; F1_hash M2_hash; F1_hash; **M1_ash**
F1_hat ; M1_at; M2_at M1_at; **M2_hat**; F1_at M2_at; F1_at; **M1_hat**	**F1_hat**; **M1_hat**; **M2_hat** **M1_at**; **M2_at**; **F1_at**	**F1_at**; M2_hat; M1_hat M1_hat; **M2_at**; F1_hat M2_hat; F1_hat; **M1_at**
M2_hate; M1_ate; F1_ate M1_ate; **F1_hate**; M2_ate F1_ate; M2_ate; **M1_hate**	**M1_hate**; **F1_hate**; **M2_hate** **M2_ate**; **M1_ate**; **F1_ate**	**F1_ate**; M2_hate; M1_hate M2_hate; **M1_ate**; F1_hate M1_hate; F1_hate; **M2_ate**
F1_hear; M1_ear; M2_ear M1_ear; **M2_hear**; F1_ear M2_ear; F1_ear; **M1_hear**	**F1_hear**; **M1_hear**; **M2_hear** **M1_ear**; **M2_ear**; **F1_ear**	**F1_ear**; M2_hear; M1_hear M1_hear; **M2_ear**; F1_hear M2_hear; F1_hear; **M1_ear**
M1_heater; F1_eater; M2_eater F1_eater; **M1_heater**; M2_eater M2_eater; M1_eater; **F1_heater**	**F1_heater**; **M2_heater**; **M1_heater** **M1_eater**; **F1_eater**; **M2_eater**	**F1_eater**; M2_heater; M1_heater M1_heater; **M2_eater**; F1_heater M2_heater; F1_heater; **M1_eater**
M2_hedge; M1_edge; F1_edge M1_edge; **F1_hedge**; M2_edge F1_edge; M2_edge; **M1_hedge**	**M1_hedge**; **F1_hedge**; **M2_hedge** **M2_edge**; **M1_edge**; **F1_edge**	**F1_edge**; M2_hedge; M1_hedge M2_hedge; **M1_edge**; F1_hedge M1_hedge; F1_hedge; **M2_edge**
M1_heel; F1_eel; M2_eel F1_eel; **M1_heel**; M2_eel M2_eel; M1_eel; **F1_heel**	**F1_heel**; **M2_heel**; **M1_heel** **M1_eel**; **M2_eel**; **F1_eel**	**F1_eel**; M2_heel; M1_heel M1_heel; **M2_eel**; F1_heel M2_heel; F1_heel; **F1_eel**
M1_hex; F1_ex; M2_ex F1_ex; **M1_hex**; M2_ex M2_ex; M1_ex; **F1_hex**	**F1_hex**; **M2_hex**; **M1_hex** **M1_ex**; **M2_ex**; **F1_ex**	**F1_ex**; M2_hex; M1_hex M1_hex; **M2_ex**; F1_hex M2_hex; F1_hex; **M1_ex**

Change trials	Catch trials	Change trials
M1_his; F1_is; M2_is	**F1_his**; **M2_his**; **M1_his**	**F1_is**; M2_his; M1_his
F1_is; **M1_his**; M2_is	**M1_is**; **M2_is**; **F1_is**	M1_his; **M2_is**; F1_his
M2_is; M1_is; **F1_his**		M2_his; F1_his; **M1_is**
M1_hobbit; F1_obit; M2_obit	**F1_hobbit**; **M1_hobbit**; **M2_hobbit**	**F1_obit**; M2_hobbit; M1_hobbit
F1_obit; **M1_hobbit**; M2_obit	**M1_obit**; **M2_obit**; **F1_obit**	M1_hobbit; **M2_obit**; F1_hobbit
M2_obit; M1_obit; **F1_hobbit**		M2_hobbit; F1_hobbit; **M2_obit**

Total number of minimal pairs used: 17

Annex I

Intensity Normalization Script

```
# May 8, 2008
# Andreia Rauber

Create Strings as file list... list *.wav
n = Get number of strings

for i to n
    select Strings list
    file$ = Get string... 'i'
    Read from file... 'file$'
    obj$ = selected$("Sound")
    Scale peak... 0.99
    Write to WAV file... 'obj$'.wav
endfor

#select all
#Remove
```

Annex J

Stimuli used in the identification test

1. Familiarization test

Distractors
She's from Japan
This is my home
This is my Omen
She loves Amsterdam
I bought a car
That's hell

2. Identification test 1 (Identify the initial sound of the last word in the sentence)

With /h/	Without /h/	Distractors
It's a scary howl	It's a scary owl	It's one hour
It's just hash	It's just ash	That's Ellen
That's my hero	That's my euro	That's hell
He said "hey"	He said "A"	This is my home
It could by handy	It could be Andy	She loves Amsterdam
It's just hair	It's just air	She loves hamsters
It's a big harbour	It's a big arbour	They don't use Iphones
It's a fine hairline	It's a fine airline	This is my Omen
That's a light halter	That's a light alter	They don't use hyphens
We said "high"	We said "I"	It's a beautiful walk
They use harrows	They use arrows	
That man is harmless	That man is armless	

3. Identification test 2 (Identify the initial sound of the word in the middle of the sentence)

With /h/	**Without /h/**
I hate apples	I ate apples
That heel is dangerous	That eel is dangerous
My heart is blue	My art is blue
Those hitters are annoying	Those eaters are annoying
The hearth is big	The Earth is big
The helm is green	The elm is green

Annex K

Computer screens of the perception test

1. General

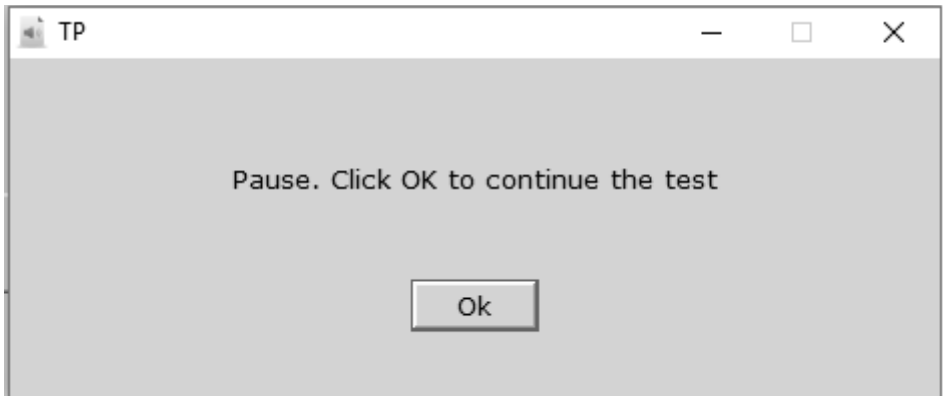


Figure 1. Message displayed to insert a pause between stimuli.

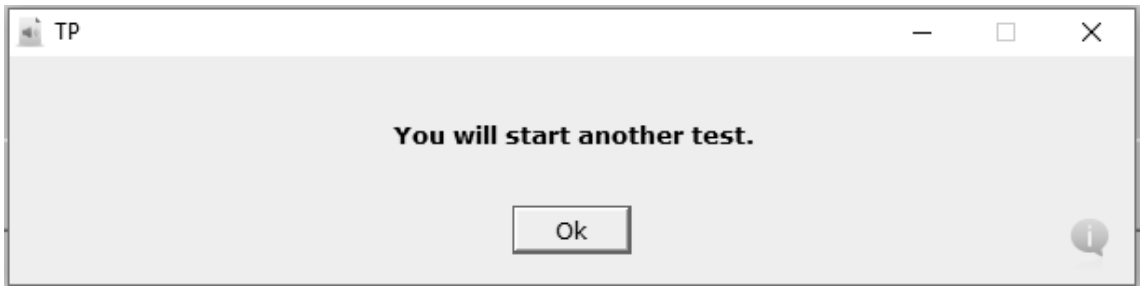


Figure 2: Message that another test would start

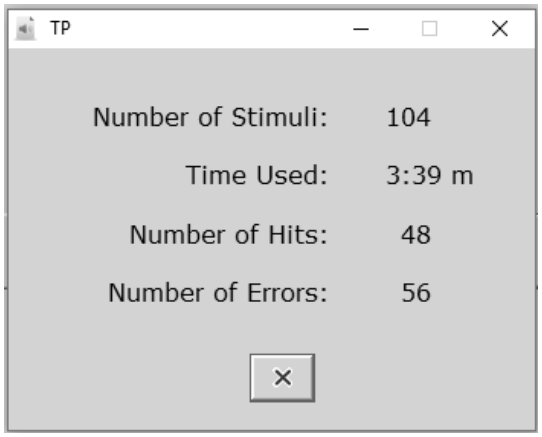


Figure 3: Example of a displayed message at the end of each task with the total number of stimuli heard, time spent, number of correct and wrong answers.

2. Discrimination test

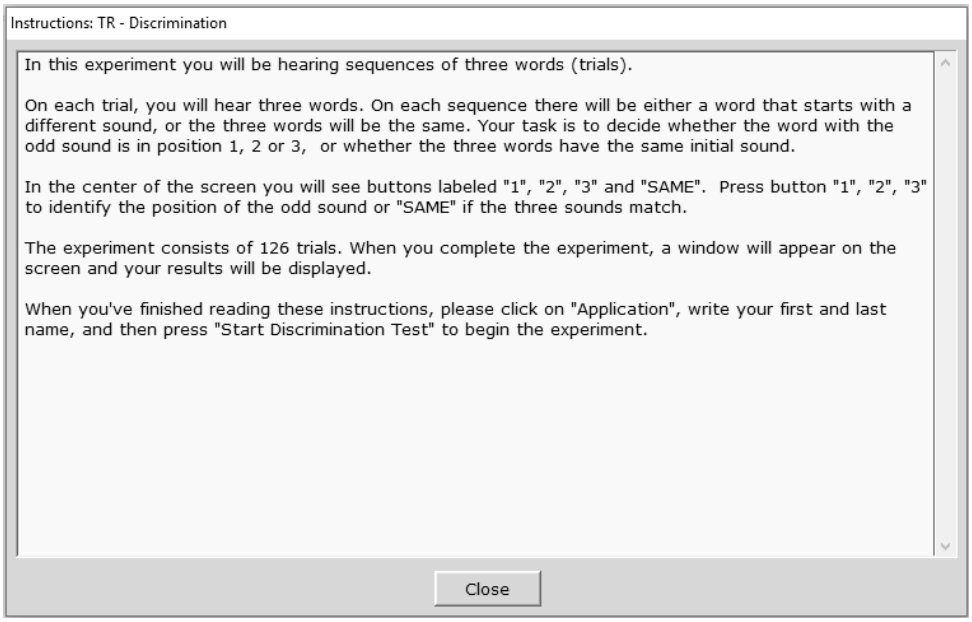


Figure 4: Instructions for the discrimination test

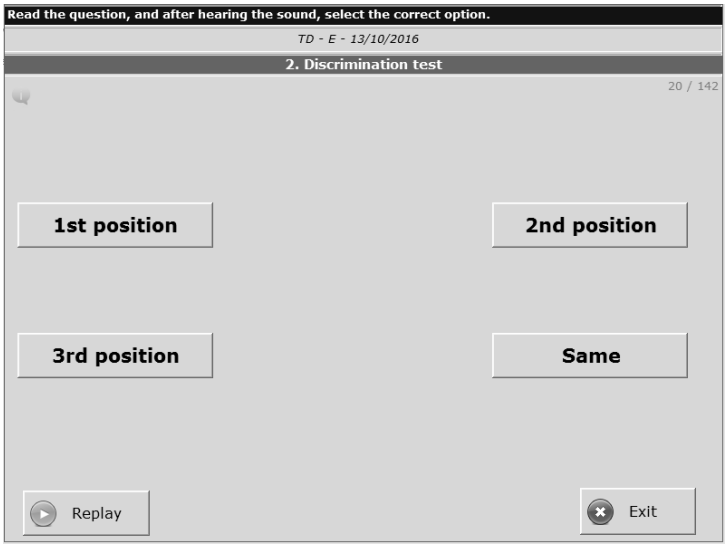


Figure 5: Computer screen from the official test

3. Identification task

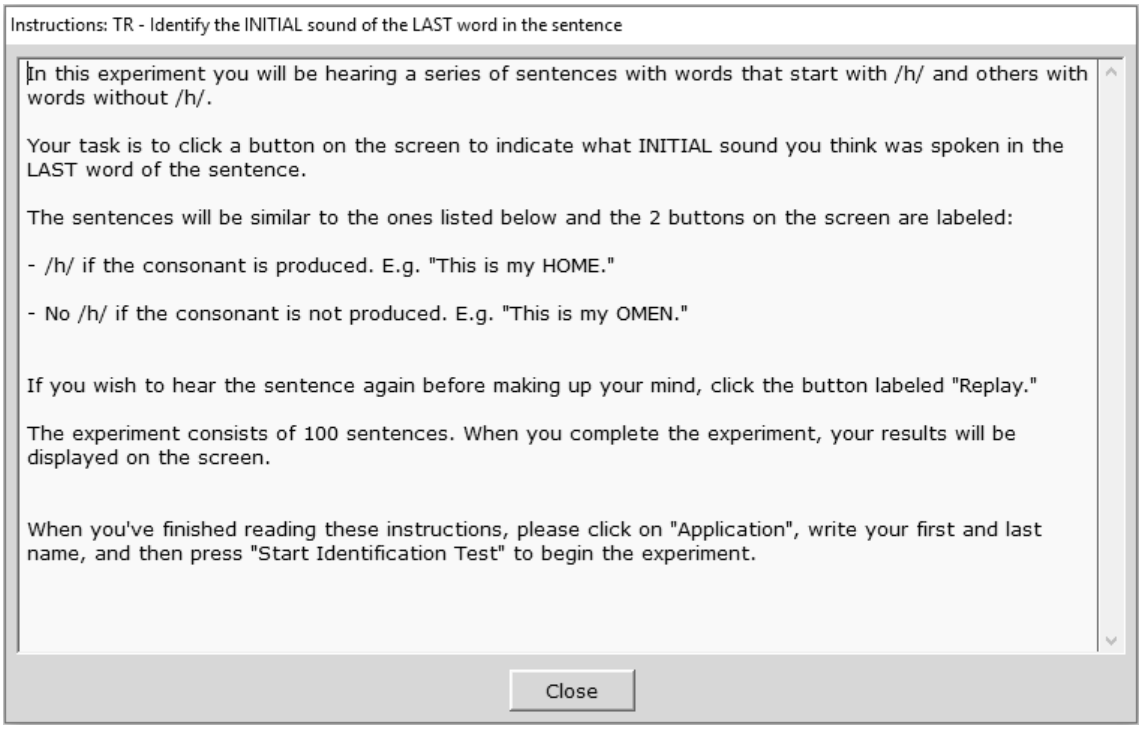
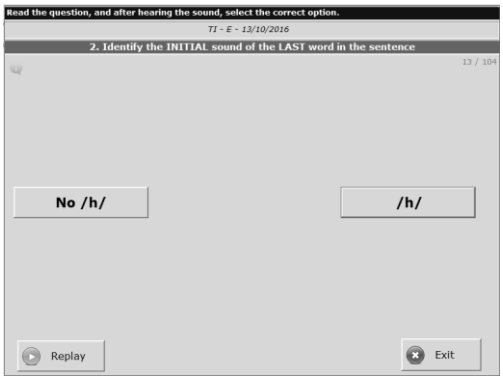


Figure 6: Instructions for the identification task



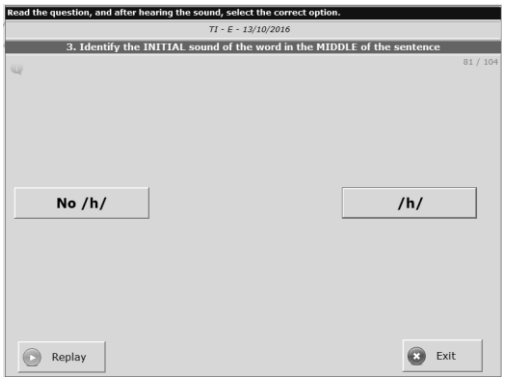


Figure 7: Computer screen of the identification task.

Annex L

Computer screens of a stimuli being analysed using *Praat*

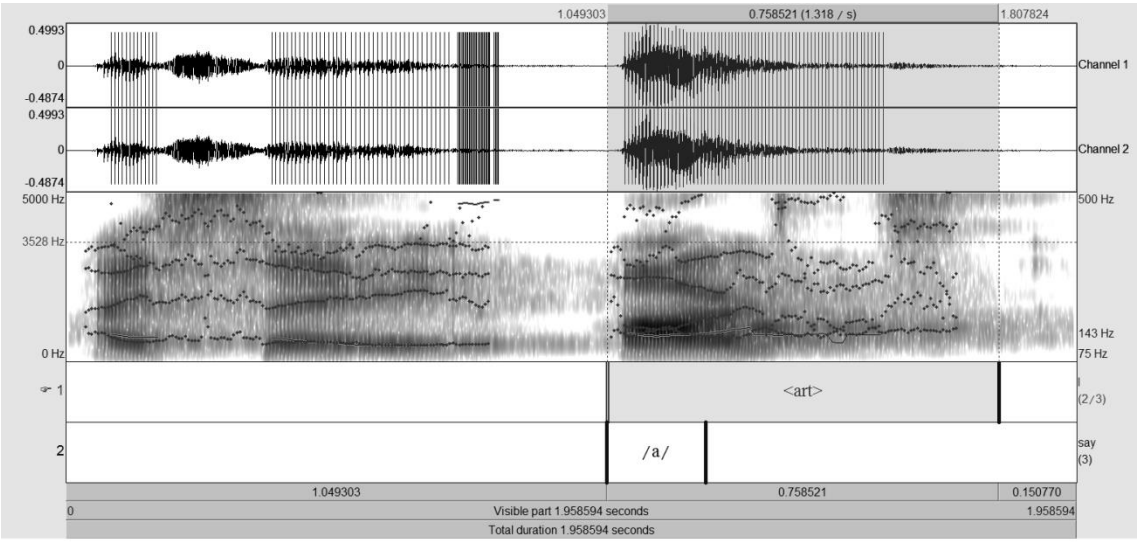


Figure 9: Soundwave and spectrogram of the sentence <I say art>.

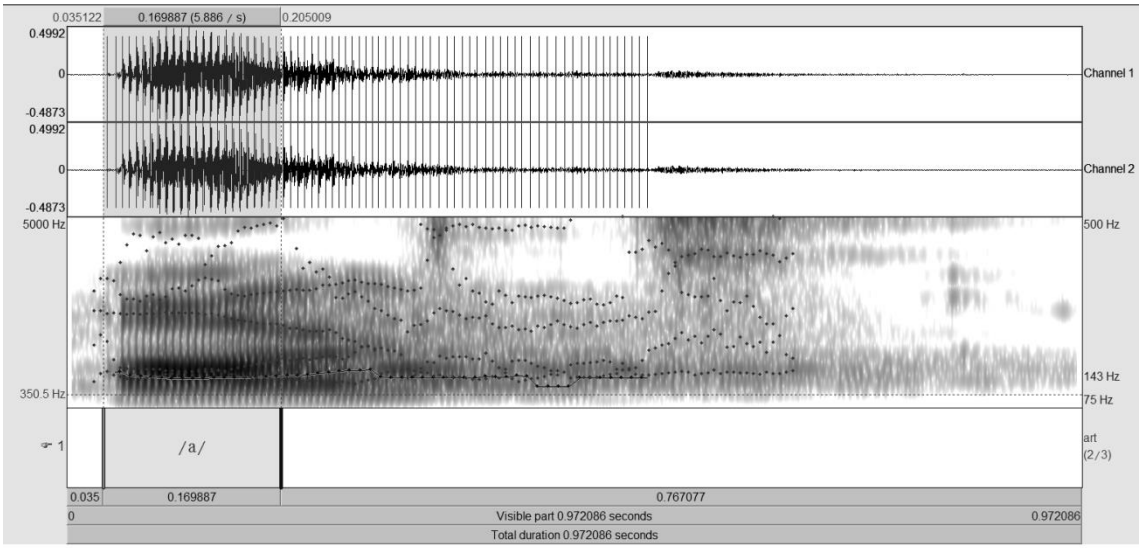


Figure 10: Soundwave and spectrogram of the word <art>.

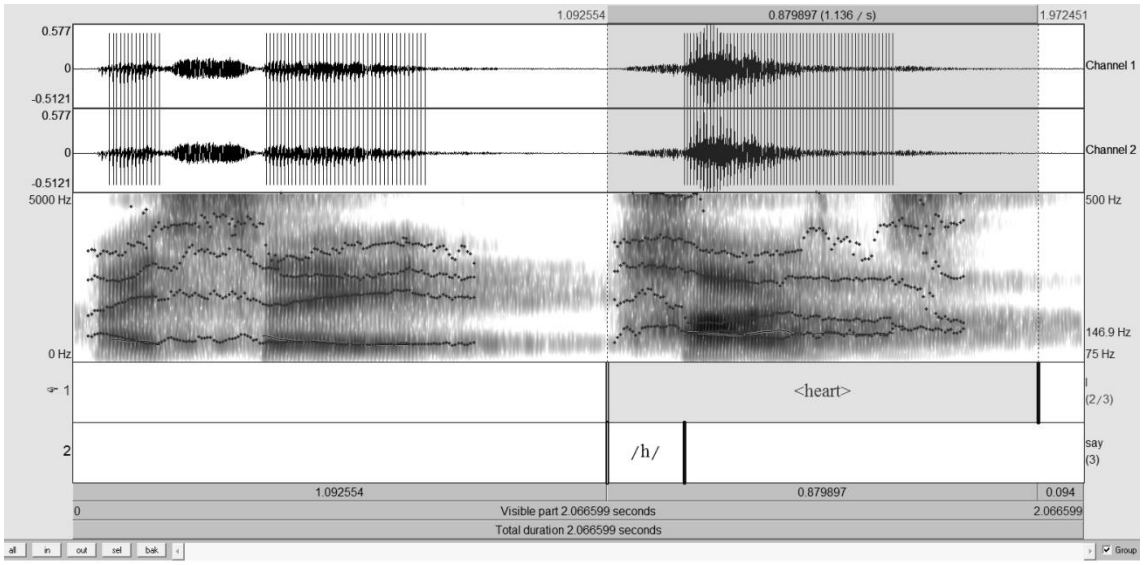


Figure 11. Soundwave and spectrogram of the sentence <I say heart>

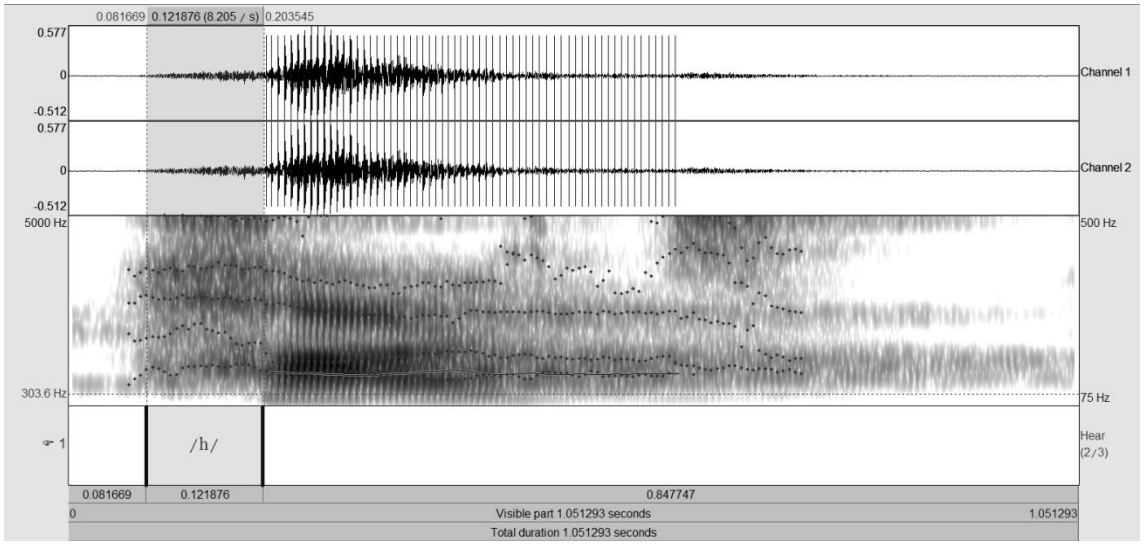


Figure 12: Soundwave and spectrogram of the word <heart> and the segmented phoneme.

Annex M

Pictures of the L2 participants performing the perception test