TRABAJO FIN DE GRADO

GRADO EN ESTUDIOS INGLESES: LENGUA, LITERATURA Y CULTURA

English, Catalan, and Spanish Vowels: Perceptual Proximity and Pronunciaton Difficulties

JAÏR LÓPEZ SAMIT

jlopez3919@alumno.uned.es

TUTOR ACADÉMICO: Silvia Carmen Barreiro Bilbao

LÍNEA DE TFG: Fonética y Fonología Inglesas

FACULTAD DE FILOLOGÍA

CURSO ACADÉMICO: 2019-20- Convocatoria: Junio

Abstract

This study analysed extant literature on vowel perceptual proximity in order to identify the difficulties encountered by Catalan and Spanish L1 speakers in the perception and production of English L2 vowels. As Catalan has a larger vowel inventory than Spanish that includes two additional open mid vowels /ɛ ɔ/ and a central weak vowel /ə/ which is very similar to the most used English vowel /ə/ (schwa), it was initially hypothesised that it would be easier for Catalan than for Spanish speakers to perceive and pronounce English vowels. The central space and the size of the vowel inventories of these languages, and the fact that all Catalan speakers are early bilinguals were found to be key factors that supported this prediction.

Key words: L2 acquisition, pronunciation, perceptual proximity, Catalan vowels, English vowels, Spanish vowels.

Acknowledgements

First of all, I would like to thank my wife Sònia and my son Dilan for their unconditional support, patience, and love. They are the most important thing in my life. I would also like to express my gratitude to my tutor, Silvia Carmen Barreiro Bilbao, for her guidance, advice and encouragement during the development of the TFG. It is also right to thank all those who have always believed in me, such as my brother Jonatan and his lovely big family, and many friends, with special reference to my dear friend and English teacher Paul Wakely and my friend Imanol Fernández, the one who made me belive in myself. Finally, I would like to dedicate this paper to my parents:

“I am sure you would be very proud of what I have done. I miss you very much”.

Jaïr López Samit

TABLE OF CONTENTS

1. Introduction 1
2. Methodology 7
3. Development 9
   3.1. L2 Acquisition 9
      3.1.1. Models and Perceptual Proximity 9
      3.1.2. Typical Methods of Acoustic Measurement and Perception 13
   3.2. Vowel Inventories 15
      3.2.1. English Vowel Inventory (RP/SSBE) 15
      3.2.2. Catalan Vowel Inventory 17
      3.2.3. Spanish Inventory 18
   3.3. Cross-language Comparative Studies 19
      3.3.1. English vs Catalan Vowels 19
         3.3.1.1. Review 19
         3.3.1.2. Conclusions 25
      3.3.2. English vs Spanish vowels 27
         3.3.2.1. Review 27
         3.3.2.2. Conclusions 32
4. Final Conclusions 35
5. Bibliography 38

1. Introduction

This paper is intended to be a review of extant literature on interlinguistic vowel comparison between English, Catalan, and Spanish. It is basically structured into five parts. In the first one, the methodology followed to carry out the present study is explained in detail. At the beginning of the development it is the second part, which is related to L2 acquisition. It includes a description of three perceptual speech models and an explanation of the common methods of acoustic measurement and perception used by researchers. In the next part, the vowel inventories of the three languages which are under study are shown. In the fourth part, several comparative vowel studies between English and the other two languages, namely Catalan and Spanish, are analysed. In this same section, conclusions are drawn from the literature reviewed. Finally, in the last part, final conclusions are drawn from the inferences made from the intelinguistic comparative studies of the previous part. These conclusions must indicate which of the L1 speakers, whether Catalan or Spanish, are the ones who face more difficulties when perceiving and producing English vowels.

It is widely known that over the last decades English has become one of the most important languages in the international panorama. It is “spoken by more than 400 million people as a first language” (L1) (Baugh, 2013, p.4) and, although it is impossible to ascertain how many people speak it throughout the world, it can be asserted that it is also spoken by many other millions of people as a second language (L2), and a as a lingua franca (ELF), that is, “a language which is commonly used by speakers who have different mother tongues and, therefore, need a common language to communicate among them” (Chacón Beltrán, 2017, p.224).

Taking into account the relevance that English has acquired in international communication, its learning has become an indispensable requirement in the educational programmes in most countries. However, it is a known fact that phonetics and phonology issues (both segmental and suprasegmental) are generally relegated to a second-class position in language learning in most of them, Spain being no exception, despite the fact that speech intelligibility is a crucial factor for adequate communication. In this sense, speakers of L1 when

learning a L2 or FL very often find it difficult to acquire both productive and receptive proper oral skills, mainly due to the poor quality and quantity of L2 input learners are exposed to. In addition, it is not a secret that most teachers of English are non-native, so their pronunciation may not be completely accurate. When learning English as a FL, there is another obstacle standing in the way: English vowel pronunciation can be confusing for L1 speakers of other languages, on account of its spelling.

> It will be noticed that the Great Vowel Shift is responsible for the unorthodox use of the vowel symbols in English spelling. The spelling of English had become fixed in a general way before the shift and therefore did not change when the quality of long vowels changed. Consequently, our vowel symbols no longer correspond to the sounds they once represented in English and still represent in the other modern languages. (Baugh, 2013, p.197)

All these facts and obstacles stress how important auditory perception and pronunciation are to establish a good communication between L1 and L2 speakers. Therefore, this study is relevant because, on the one hand, it identifies the weaknesses that Catalan and Spanish speakers show when perceiving and producing English vowels, and, on the other hand, because being aware of these weaknesses can be seen as the first step in improving their productive and receptive skills. So, the present paper is clearly motivated by this yearning for improvement.

Initial Hypothesis

Considering the facts that Catalan has a wider vowel inventory and that it has more open vowel sounds than Spanish, and that schwa /ə/ (*vocal neutra* in Catalan) is the most common weak vowel in both Catalan and English languages, the initial hypothesis of this research is that it will be easier for L1 Catalan speakers than for L1 Spanish speakers to produce and perceive L2 English vowel sounds.

As for the general goals, the present paper is intended both to study the similarities and dissimilarities among English and Catalan and Spanish vowel pronunciation and to try to determine whether proximity between vowel sounds of these languages can be seen as advantageous or disadvantageous. In other words, it mainly attempts to identify the difficulties encountered by both Catalan

and L1 Spanish speakers when perceiving and producing L2 English vowels. It also tries to draw some conclusions by comparing the inferences made in two comparative studies, that is, the comparative reviews of English vowel sounds and the other two languages vowel sounds. In addition, this paper attempts to be helpful for non-native teachers who teach English either in Catalan or in Spanish schools and also for further study development, so it would be interesting to extend this study to vowels in consonantal context and diphthongs.

State of the Question

There are several speech perception models that address the issue of L2 sound acquisition in accordance with the interplay between L1 and L2 systems. The Native Language Magnet (NLM) (Kuhl & Iverson, 1995) states that "language and perceptual abilities are innate and are later affected by the speaker's experience with the L1" (Foresti Carlet, 2017, p.10). It also postulates that

> [...] non-native sound perception occurs within the native language boundaries. In, fact, the authors explain that good exemplars of L1 speech sounds act as perceptual magnets and thus attract percetually similar target sounds, which impede the formation of new categories. (Foresti Carlet, 2017, p.1)

Another model is the Perceptual Assimilation Model (PAM) (Best & Tyler, 2007), which suggests that L2 sounds are assimilated by L1 phonetic categories in varying degrees, according to the level of perceptive and speech articulation similarity between the sounds of both languages.

The last speech model to be analysed is Flege's Speech Language Model (SLM) (Flege, James Emil, 2015) that asserts that "a non-native sound that is dissimilar to a pre-existing L1 sound will eventually be acquired with more ease than an L2 sound that has a similar counterpart in the L1 language inventory" (Foresti Carlet, 2017, p.1) and predicts that "the greater is the perceived phonetic dissimilarity of an L2 speech sound from the closest L1 sound, the more likely is that a new category will be created for the L2 sound" (Schiller & Meyer, 2003, p.10).

Flege classifies L2 sounds into three groups: identical, similar, and new. The identical sounds are those L1 sounds that could be considered as native if they

are produced in L2 (for instance, L2 English /i:/ is identified with L1 Catalan /i/); the similar ones are those L1 and L2 sounds that, although display certain acoustic differences, are equated with each other (for instance, L2 English /ʌ/ is identified with L1 Catalan /a/) ; and the new ones are those L2 sounds which are entirely distinct from any L1 sound (for instance, L2 English /ɜ:/ has no clear match in L1 Catalan). According to Flege, bilinguals cannot separate their L1 and L2 sound systems, and, therefore, there will always be L1 interferences when learning L2.

As for the age of L2 acquisition, Lenneberg's Critical Period Hypothesis (CPH) holds that, due to the general learning failure among adult L2 learners, there is a critical period for language learning, so it asserts that all those who learn a new language after puberty will be marked by a foreign accent (FA) (Schouten, 2015, p.1). In contrast, both SLM and NLM "proposes that native versus non-native differences are more likely to arise as the result of interference from prior phonetic learning than from a loss of neural plasticity" (Schiller & Meyer, 2003, p.10).

It is worth saying that these three speech models (NLM, PAM, and SLM) mantain that experience and exposure to good quality L2 input are of paramount importance to L1 speakers to properly develop their receptive and productive oral skills in L2. In this vein, it is worth mentioning that phonetic training can be of great help when L2 input is poor (Foresti Carlet, 2017, p.10) .

Thus, according to the researcher Juli Cebrian, one of the first steps to be made when studying the acquisition of the L2 sound system is to determine the degree of perceptive proximity between the sounds of both languages (Cebrian, 2013). As it will be explained later, comparative studies of L1 and L2 sounds can be carried out by comparing inventories, by comparing acoustic measurements, and by comparing perceptions (Cebrian, 2019a, p.25).

With respect to English, Catalan, and Spanish vowel inventories, it is worth noting that English (RP and Standard Southern British English) has the largest one. It includes 11 stressed phonemes and one unstressed phoneme, schwa /ə/. English has 8 diphthongs as well: 5 falling diphthongs and 3 centering diphthongs. It is important to emphasise, however, that this study is intended to analyse

monophthongs in isolation, so diphthongs and vowels in company will not be addressed in this paper. Southern British English (SBE or RP) vowels, unlike Catalan and Spanish vowels, are determined by two parameters: quality and length. There are 5 tense (long) vowels and 6 lax (short) vowels. The diacrític mark **:** always goes with the long vowels (/i:/, /u:/, /a:/, etc.).

As far as the Central Catalan vowel inventory is concerned, it is constituted of eight vowels that are only spectrally distinct, seven stressed peripheral phonemes" and "a reduced vowel in unstressed position" (schwa /ə/ o *vocal neutra*) (Foresti Carlet, 2017, p.53). Conversely, Catalan has a higher amount of diphthongs than English.

Finally, the Spanish vowel inventory is the one that contains less sounds. It comprises five vowel sounds /a,e,i,o,u/. Just like Catalan vowels, the Spanish ones are only determined by quality.

As for the comparative studies between the vowels of the three languages, it is important to ascertain how close Catalan and Spanish vowel sounds are to the English ones, and to predict how difficult it will be for both Catalan and Spanish L1 speakers to detect and pronounce these English sounds. In terms of proximity, for instance, English /i:/ and /ɪ/ are different vowel sounds. Whereas Catalan and Spanish L1 speakers mostly assimilate English /i:/ to their almost identical L1 /i/, English /ɪ/ is mostly mapped onto Catalan /e/ and Spanish /e/ (which are also distinct from one another, as Spanish /e/ is a bit more open than Catalan /e/, so Catalan /e/ is closer to English /ɪ/ than Spanish /e/) and to a lesser extent to Spanish /i/ (Cebrian, 2019b; Foresti Carlet, 2017; Schiller & Meyer, 2003).

Others predict that English /æ/ is acoustically close to Catalan /a/ as well as English /ʌ/ and /ɑ:/. However, these latter two English vowel sounds "are lower than Catalan /a/, indicating the central nature of the Catalan vowel as compared to the English targets" (Rallo Fabra, 2008, p.575). A study by Juli Cebrian also predicts that /i ɛ a/ Catalan vowels are highly close to /i ɛ æ/ English sounds (Cebrian, 2013, p.3).

On the other hand, and with regard to the vowel length, although spectral differences are the main cue that distinguishes English vowel sounds, the

duration of the sound also has its significance. According to Angelica Foresti Carlet,

> Catalan learners of English have often been shown to fail to make use of spectral cues when discerning English /i:/-/ɪ/ pair and consequently to rely mostly on temporal cues to distinguish the two sounds in both their perception and production. (Foresti Carlet, 2017, p.56)

In this case, although vowel length is not a factor to be considered in Catalan vowel sounds, some Catalan learners resort to vowel sound duration in order to identify the English vowel sound. In the same vein, as mentioned above, English /ɪ/ is mostly identified by Spanish learners of English as Spanish /e/. However, "English /ɪ/ tends to be mispronounced as Spanish /i/ more than as /e/, which may result from the influence of orthography or the unfortunate habit of teaching the /i:/-/ɪ/ contrast as long /i/-short /i/ opposition to L2 English learners" (Cebrian, 2019b, p.57). Possible errors in teaching like this show that the quality of L2 input sometimes leaves much to be desired. In this respect, over the last decades phonetic training has gradually gained in prominence, since it has been proven that it improves and increases the quality and the amount of L2 input for learners who live in non-native L2 speaking countries.

The experiment carried out by Montserrat Casanovas Catalá, in which three English L1 speakers who lived in Catalonia and with different experience in Catalan language as L2 are analysed, points out the importance of experience and training when learning L2 (Catalá, 1994). This paper shows that the English native speaker who had more experience in learning Catalan as L2 was the one that better developed his perceptive and productive oral skills, so he was able to better discern Catalan /ɛ/-/e/ and /ɔ/-/o/.

It is also interesting to have a look at some studies designed to teach English learners of Catalan or Spanish. In this sense, they make similar mistakes and assimilations the other way round. In this context, some English L1 speakers sometimes produce long vowels when they do not exist either in Catalan or in Spanish languages. So it is not uncommon to listen to L1 English speakers producing Catalan words such as *pis* [pis] with a long vowel [pʰi:s] (Catalá, 1994, p.17).

2. Methodology

As said above, this paper was intended to be a review of extant literature about the different issues which are related to English, Catalan, and Spanish vowel sound production, perception, and acquisition. And although this is by no means an empirical research, empirical research from other studies were essential to achieve the aims proposed.

Firstly, some key concepts and three speech perception models of L2 acquisition (SLM, NLM, and PAM) were briefly described. This description was crucial to understand the relevance of perceptual proximity in cross-language studies. The next step was to depict the methods and techniques followed by the authors in their research and experiments. Three kinds of comparative methods were commonly used by them: comparison of inventories, acoustic/articulatory comparison, and perceptive comparison. Subsequently, the vowel sound inventories of Catalan, English, and Spanish were exposed.

Later, several comparative studies of English and Catalan vowels were analysed. Some of them were articles (Cebrian, 2006; Souza, Carlet, Jułkowska, & Rato, 2017; Zhang, 2019) published in prestigious journals, such as the *Journal of the Acoustical Society of America*, or the *Journal of Phonetics*. Others were studies included in chapters of books, such as (Cebrian, 2019a). A PhD Dissertation was also reviewed (Foresti Carlet, 2017).

Likewise, several papers comparing English and Spanish vowels were reviewed as well. Some of them were books (González Gómez, María de los Angeles & Sánchez Roura, 2016), others were articles published in prestigious journals (Cebrian, 2019b; Escudero & Chládková, 2010; Iverson & Evans, 2009) or in conference proceedings (Morrison, 2003). It has to be mentioned as well, that some web pages were also referred to in this study, such as the home pages of James Emil Flege (Flege, James Emil, 2006) and Jack Windsor Lewis (Lewis).

Thereupon, after having reviewed the selected literature, conclusions were drawn from all the quantitative and qualitative data extracted from both Catalan-English and Spanish-English comparative studies. These conclusions determined the degree of perceptive proximity between Catalan and English vowel sounds and between Spanish and English vowel sounds. Having done so, the last phase was

devoted to drawing final conclusions from the inferences made in the two comparative studies and to try to ascertain whether such conclusions supported the initial hypothesis or not.

3. Development

3.1. L2 Acquisition

As this study deals with English as a L2, it is necessary to take a look at some aspects of L2 acquisition. Although it is a complex issue and it is not the main object of study of this paper, it is directly related to how L1 speakers perceive and produce L2 sounds. Hence, for the purpose of this research, some phonetic and phonological aspects involved in L2 acquisition must be considered.

3.1.1. Models and Perceptual Proximity

As Juli Cebrian asserts (Cebrian, 2013), the concept of similarity or proximity between the sounds of the mother tongue (L1) and the target language (L2) is a key concept in L2 (or FL) phonological acquisition theories. This is because in order that the learner can produce and perceive the target language sounds as similar as possible to those of the L2 native speakers, it is necessary that the L2 learner establishes target language phonetic categories as close as possible to those of L2 native speaker categories.This task is hampered by the fact that adult language learners already have an extant phonological system with its own phonetic categories which interfere in the creation of L2 categories. This section thus is intended to offer an overview of the main tenets of three of the most well known speech perception models that account for L2 phonological acquisition.

To begin with, the Native Language Magnet (NLM) model (Foresti Carlet, 2017; Kuhl & Iverson, 1995) postulates that the fact that infants are exposed to the language spoken by their guardians results in the creation of phonetic representations that are essential for the perception of both native and non-native sounds. This theory also holds that the ability to separate the sounds into bounded spaces is innate in human beings. This separation allows infants to discern between sounds that belong to different phonetic categories, but, on the other hand, they cannot discriminate the ones which are located within the same space sound’s boundaries, that is, within the same phonetic category.

In short, infants, during the first year of life, develop a frame of phonetic categories based on L1 that will be kept over their whole lifetime. All new sounds, thus, will be perceived, both by infants and adults, within the L1 phonological

system. In this same context, speakers create phonetic prototypes (the best examples of each sound) in their L1 phonetic frame which attract the other phonetic units that are located within the same sound boundaries (phonetic category) as if they were magnets. Connecting this phenomenon with L2 sound acquisition, and focusing on the purpose of the present paper, “L2 sounds that are perceptually comparable to L1 sounds may be perceived as poor examples of L1 sounds at first and thus mapped onto preexisting L1 categories” (Foresti Carlet, 2017, p.11).

Therefore, NLM postulates that when a certain sound of L2 is similar to a sound of L1, the L1 magnet effect makes it difficult to distinguish the L2 sound from the L1 sound. By contrast, when a certain sound of L2 is dissimilar to a sound of L1, the magnet effect remains inactive and does not affect the L2 perception, so it is therefore easier to discriminate the L1 sound from the L2 sound. NLM also maintains that speech perception alters speech production.

Secondly, the Perceptual Assimilation Model (PAM) (Best & Tyler, 2007; Foresti Carlet, 2017) is based on the Direct Realist theory of speech perception in which the object of study are sounds that are conceived as groups of speech gestures instead of mental representations of phonetic categories; these speech gestures can be identified by acoustic signal.

PAM was later extended to L2 perception (PAM-L2) (Best & Tyler, 2007). This model also takes similarity and dissimilarity between L1 and L2 sounds as a reference to predict how L2 sounds are perceived by non-native listeners. In this sense, when a L2 sound is perceived as existing in L1 it is said that this L2 sound is categorised. In contrast, a L2 sound which is not perceived as existing in L1, it is identified as uncategorised. So L2 learners assimilate new L2 sounds to L1 similar categories rather than create new ones. According to PAM-L2, there are several types of assimilation:

a) the Two-Category assimilation (TC), that occurs when two L2 sounds are perceived as two different L1 categories. In this case, an excellent discrimination effect is expected;

b) the Category-Goodness assimilation (CG), that takes place when two L2 sounds are perceived as one L1 category, but one conforms more closely

to the L1 sound than the other. In this case, a moderate to very good discrimination effect is predicted;

c) the Single-Category assimilation (SC), that occurs when two L2 sounds are perceived as the same L1 sound, but neither of them conforms more closely to the L1 sound than the other. When this type of assimilation takes place, a poor discrimination effect is expected;

d) the Uncategorised-Categorised assimilation (UC), that takes place when one out of two L2 sounds is assimilated to a L1 sound but the other is not categorised. In this case, the discrimination effect is expected to be very good;

e) the Uncategorised-Uncategorised assimilation (UU), that occurs when two L2 sounds are uncategorised. When this type of assimilation takes place, the discrimination effect is predicted to be poor to moderate. .

To sum up,

> The basic premise of the PAM is that what naïve listeners perceive when they hear an unfamiliar language are the similarities and dissimilarities between its patterns and the familiar patterns of their native language. Therefore, when a sound is not in the listeners' native language, they assimilate it to the closest native sound or, in the extreme case, cannot classify it as a speech sound at all. (Borden, 2011, p.228)

The last speech model to be considered in this section is Flege's Speech Learning Model (SLM) (Flege, James E., 1995; Flege, James E., 2007; Flege, James Emil, 2015; Foresti Carlet, 2017), that differs from NLM and PAM in that not only does it takes into account speech sound perception, but also speech sound production. SLM also differs from PAM in that the former focuses on experienced listeners, whilst the latter focuses on unexperienced listeners.

SLM began with two controversial assumptions: the first, which is in contrast to Lennenberg's Critical Period Hypothesis (CPH), maintained that L2 speech learning is not constrained by a critical age period, and the second held that the capacities required by children to learn L1 remain available in their adulthood when they learn an L2. According to SLM, L1 and L2 sound systems share a common phonological space and as a result they influence one another. In other

words, there is a cross-linguistic interference between L1 and L2. When L1 and L2 interact two phenomena can take place:

a) Phonetic Category assimilation: it takes place when a particular L2 sound is close to an L1 phonetic category, so both sounds are perceived to be phonetically similar. Then the category formation of the L2 sound is blocked by equivalence classification, that is, the L2 sound is assimilated by the L1 phonetic category. With an increase in L2 experience discrimination between these similar sounds can be attained over time by learners of L2.

b) Phonetic Category Dissimilation: it takes place when an L2 sound is sufficiently dissimilar to the closest L1 phonetic category and a new category for this L2 sound is established.

In this sense, SLM suggests that the more dissimilar an L2 sound is to an L1 phonetic category, the easier it will be to be acquired by L1 speakers; and, obviously, the more similar an L2 sound is to an L1 phonetic category, the more difficult it will be to be acquired by L1 speakers. In accordance with SLM, thus, L2 sound perception can be classified into three categories: identical, similar and new. The identical are those L1 sounds that are considered as native if they are produced in L2 (English /i:/ and Catalan or Spanish /i/); the new ones are those produced by phonetic category dissimilation (English /ɜ:/ has no clear match neither in Catalan nor Spanish); and the similar ones are those produced by phonetic category assimilation (English /ʌ/ is identified with Catalan /a/).

Finally, and with respect to speech production, SLM maintains that L2 sound perception is closely related to L2 sound production, so phonological errors may be caused, among other things, by incorrect perception.

By a way of summary, the three models have in common the fact that L1 phonological system interferes with L2 phonological acquisition, and, thereby, in the perception of L2 sounds and their proximity or similarity to L1 sounds; and that a good quality and amount of L2 input and long exposure to L2 can improve L2 perception and, according to SLM, also production.

3.1.2. Typical Methods of Acoustic Measurement and Perception

By now, and according to the speech models analysed above, it has been assumed that proximity or similarity between L1 and L2 sounds is essential in order to determine the difficulty to both perceive and produce L2 sounds by L1 speakers. So now it is time to take a look at how sound proximity or similarity can be measured. Much of the research employed to carry out the present study was conducted through methods of acoustic measurements or methods of interlinguistic sounds perception (by means of perceptual judgments).

Vocal tract ressonances are known as formants (Borden, 2011, p.95), and they can be identified by frequency peaks of speech sound production. These ressonances, thus, are mainly determined by how they are articulated and by the resonating cavities generated by the articulators in the vocal tract. The first two formants of a sound, that is F_1 and F_2, are closely related to the vowel height (high to low) and the position of the tongue (front to back) respectively. In this sense, high vowels such as English /i:/ have low F_1 frequencies; in contrast, low vowels such as English /ɑ:/ have high F_1 frequencies. On the other hand, front vowels such as English /i:/ or /e/ have high F_2 frequencies; conversely, back vowels such as English /u:/ or /ɔ:/ have low F_2 frequencies. F_0 is the frequency produced at the vocal folds, which is known as the fundamental frequency, and "the third formant" (F_3) "is responsive to front versus back constriction" (Borden, 2011, p.96). In other words, a vowel can basically be determined by its F_1 and F_2.

Hence, as far as vowel acoustic research is concerned, speech recordings can be analysed by specialised software, such as the well-known program Praat (Boersma & Weenink), whereby spectrograms of speech production can be obtained in order to ascertain sound formants. One of the problems found by researchers is that "Absolute frequencies cannot be given because ressonance characteristics of each vocal tract differ from those of every other" (Borden, 2011, p.104), that is, that "'the same' phonological vowel uttered by different speakers will show formants at different frequencies due to the different sizes of the speakers' vocal tracts" (Flynn, 2011, p.1).

Apart from differences among individual speakers' vocal tracts, differences can also be found between male, female, and children's vocal tract sizes. In this

respect, male vocal tracts are bigger in size than female's, and female vocal tracts are bigger in size than children's. As a result of these differences, the values for the formants of a particular vowel can significantly differ from each other depending upon who produces it. The solution to this problem is

> [...] in principle, to remove as much of the inter-speaker formant value differences due to biological differences as possible. This would leave quantities unaffected by the size of speaker's vocal tract, and so would be directly comparable. The process of transforming formant frequencies to make them directly comparable with those from other speakers is called Vowel Formant Normalisation. (Flynn, 2011, p.2)

Simply put, vowel formant frequencies produced by different speakers cannot be directly compared, but formant mean values can be obtained by means of formant normalisation. There are several methods of frequency formant normalisation such as Lobanov's z-score or Nearey's Constant Log Interval Hypothesis (CILH) (Vives, 2008) or the Bark Difference Metric or Labov ANAE method, just to mention a few examples.

By the process of normalisation, thus, formants' mean values as well as the spaces of dispersion of the vowels of a certain language can be acoustically measured and compared with others. In this sense, many of the more recent studies about language inventories include normalised formants. It is worth mentioning that there is a very useful online tool called NORM (Thomas & Tyler Kendall, 2007) that allows researchers to introduce formant data from different speakers and it normalises the formants according to the method chosen by the researcher. Therefore, and focusing on the goal of this paper, proximity or similarity between vowels of different languages can thus be determined acoustically.

As for perceptual judgments, it is the most used method by the researchers that are referred to in the present study. A good example of this is one of the leading figures in cross-linguistic studies on pronunciation between English and Catalan languages, Juli Cebrian. In his research published in 2013 (Cebrian, 2013), for instance, he makes use of two different interlinguistic perception tasks: a direct task in which listeners compare the degree of similarity and dissimilarity between a pair of acoustic stimuli of the two languages under study, and an indirect task in which the stimuli of one of the languages are compared with the mental representations of the target language sounds by means of interlinguistic

identification. The former, known as Rated Dissimilarity Task, involves the participants in the study listening to pairs of stimuli in order to judge the degree of dissimilarity between them; the latter, known as Perceptual Assimilation Task, implies the identification of a target language sound in terms of native language categories and the judgment of the level of correction or authenticity of such a sound.

3.2. Vowel Inventories

Before analysing the comparative studies of English and Catalan or Spanish vowels, a general overview of the vowel systems of the three languages must be carried out. Nevertheless, it is important to mention that the present paper is intended to analyse monophtongs in isolation, so diphthongs and vowels in company are beyond the scope of this study.

3.2.1. English Vowel Inventory (RP/SSBE)

Although RP is an accent that is only used by about 3% of native speakers of English in England (Trudgill, 2017), it is the one that

> [...] is universally understood by native English speakers and foregin speakers alike, and therefore the standard accent described in most books and materials of British English as a foregin language. (Estebas Vilaplana, 2016, p.17)

RP pure vowels can be considered to have the same quality as those of the Standard Southern British English (SSBE) when treated in isolation, hence both RP and SSBE will be here addressed indistinctly. It is also important to point out that, unlike Catalan and Spanish vowels, SSBE vowels are not only determined by quality, but also by length. Notwithstanding, this work is only intended to analyse vowel quality, since, at least in some varieties of English, “duration is a secondary cue” (Foresti Carlet, 2017, p.55).

The RP inventory consists of 11 stressed phonemes /iː ɪ e ɜː æ ʌ ɑː ɒ ɔː uː ʊ/ and one which is unstressed, schwa /ə/. “The length mark : is used to the long vowels, though this is actually redundant since the vowel symbols already successfully distinguish each vowel from every other” (Roach, 2004, p241).

In this context, RP English vowels can be defined as follows:

/iː/: front, close (or high), unrounded, and long.

/ɪ/: front, half-close, unrounded, and short.

/e/: front, between half-close and half-open (or mid), unrounded, and short.

/æ/: front, between half-open and open, unrounded, and short.

/ʌ/: central, open (or low), unrounded, and short.

/ɑ:/: back, open (or low), unrounded, and long.

/ɒ/: back, open (or low), rounded, and short.

/ɔ:/: back, between half-close and half-open (mid), rounded, and long.

/ʊ/: back, half-close, rounded, and short.

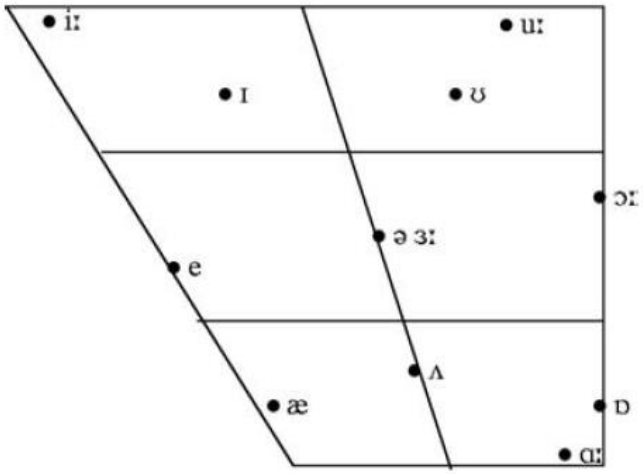
/u:/: back, close (or high), rounded, and long.

/ɜ:/: central, between half-close an half-open (mid), unrounded, and long.

/ə/: central, between half-close an half-open (mid), unrounded, and short.

It is worth noting that schwa (/ə/) is “by far, the most frequently used vowel in English” and “it only occurs in unstressed syllables” (Estebas Vilaplana, 2016, p.60). With regards to the acoustic description, there are many studies and books that provide average formants for the English vowels in Hz (Borden, 2011; Cruttenden, 2014; González Gómez, María de los Angeles & Sánchez Roura, 2016), although, as said above, it is very difficult to find accurate results without normalising the data.

Figure 1. The SSBE Cardinal Vowel chart (Roach, 2004, p.242)



3.2.2. Catalan Vowel Inventory

Catalan is a Western Romance language spoken by more than 10 million people in four states: Andorra, Spain (Catalonia, Valencia region, the Balearic Islands, and some parts of Aragon), France (in the south), and Italy (in the town of l'Alguer on the island of Sardinia) (Institut Ramon Llull). It is the ninth most spoken language in the EU.

Catalan is divided into two fundamental varieties: Western and Eastern Catalan. The one under study in the present paper is Eastern Catalan, which include seven stressed peripheral vowels /a ɛ e i ɔ o u/, and an unstressed schwa-like vowel called *vocal neutra* /ə/. It is important to note that when they are found in unstressed syllables the phonemes /a e ɛ/ are reduced to /ə/ (Foresti Carlet, 2017, p.53) . That means that, as with English schwa, Catalan /ə/ is one of the most used vowel sounds. On the other hand, length is not an identifying feature of Catalan vowels, so they can be described only in terms of quality.

In this respect, Eastern Catalan vowels can be defined as follows:

/i/: front, close (or high), and unrounded.

/e/: front, half-close, and unrounded.

/ɛ/: front, half-open, and unrounded.

/a/: central, open (or low), and unrounded.

/ɔ/: back, half-open, and rounded.

/o/: back, half-close and rounded.

/u/: back, close (or high), and rounded.

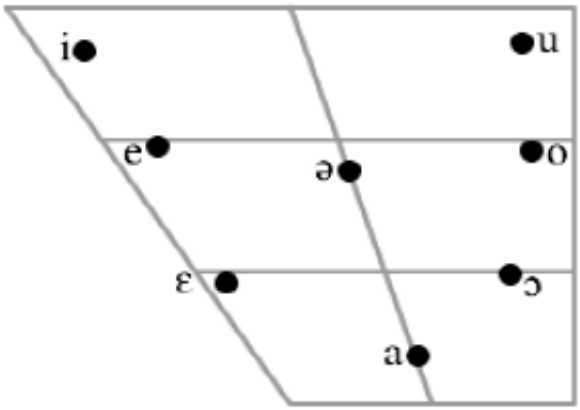
/ə/: central, mid, and unrounded.

A complete Catalan vowel system description can be found in one of the most well-known books on Catalan phonetics and phonology written by Daniel Recasens (Recasens i Vives, 2014) , in which some mean values for Catalan Eastern (*Català Oriental*, in Catalan) vowel formants in Hz can also be found (Recasens i Vives, 2014, p.21). A study of vowel identification through relative frequencies of formants' intervals (F_0-F_1, F_1-F_2, and F_2-F_3) is available in an article

written by Sílvia Planas Morales (Morales, 2007) published in the scientific journal *Phonica*.

Finally, a full description of Catalan vowel sounds and their normalised formant values as well as a brief history of phonology and phonetics of Catalan language can be found in the doctoral dissertation of Agnès Rius-Escudé (Rius-Escudé, 2016).

Figure 2. The Catalan Cardinal Vowel Chart (Foresti Carlet, 2017, p.54)



3.2.3. Spanish Inventory

The Spanish language is nowadays spoken by 480 million people in the world as a mother tongue. It is the third most spoken language in the world, only exceeded by English and Mandarin Chinese (Instituto Cervantes). As for its vowel System, it is made up of just five phonemes, that is, /i e a o u/. One of the advantages of Spanish vowel sounds is that, apart from remaining “stable throughout multiple dialects”, they “are closely tied to the graphemes *i, e, a, o, u*” (Jeske, 2012, p.7). In contrast to English and Catalan vowel sounds, Spanish vowels are merely classified into three mouth opening levels: high (or close), mid, and low (or open). Thus, Spanish vowels can be defined as follows:

/i/: front, high (or close), and unrounded.

/e/: front, mid, and unrounded.

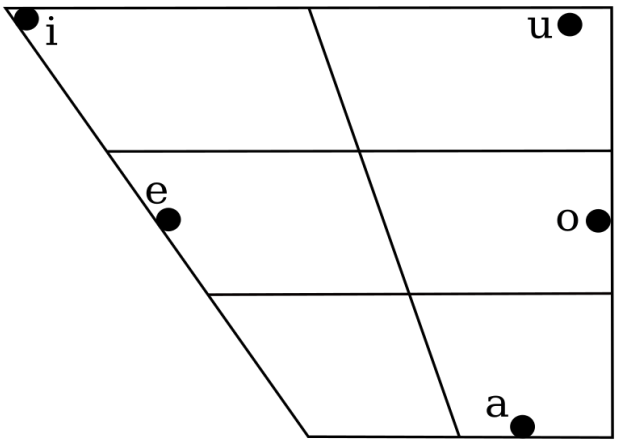
/a/: central, low (or open), and unrounded.

/o/: back, mid, and rounded.

/u/: back, high (or close), and rounded.

As for the acoustic description, a study on Spanish vowel dispersion space can be found in a journal article by Anna M. Fernández (Planas, 1993). Eugenio Martínez Celdrán in one of his articles (Martínez Celdrán, p.201) provides Spanish vowels' standard mean formant values for both men and women, as well as Ann R. Bradlow in one of her articles published in *The Journal of the Acoustical Society of America* (Bradlow, 1995, 1918), or in an article written by Andrew R. Jeske (Jeske, 2012, p.9) in which mean formant values for Spanish and English (in this case for American English) vowels extracted from previous studies ara available.

Figure 3.The Spanish Cardinal Vowel Chart (Wikipedia)



3.3. Cross-language Comparative Studies

Having provided the vowel inventories of the three languages under study in this paper, now it is time to focus on comparative studies between English and Catalan and Spanish vowel systems.

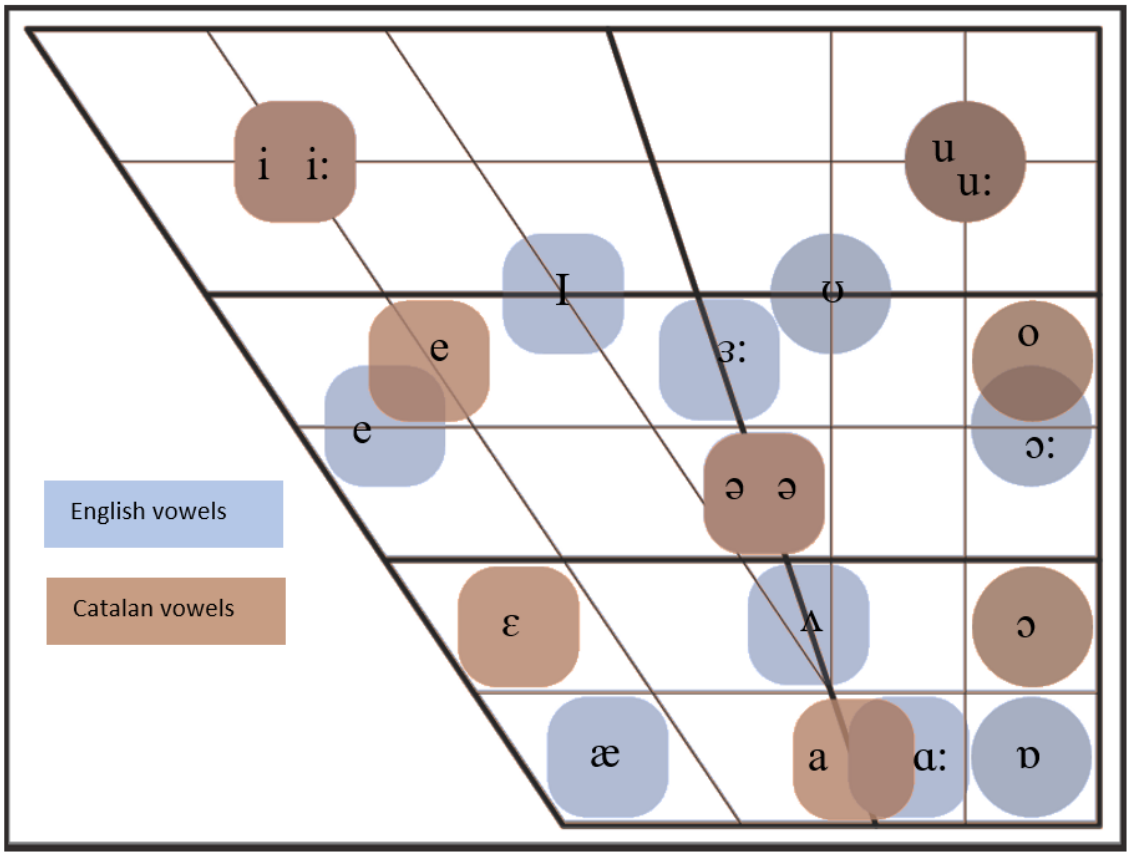
3.3.1. English vs Catalan Vowels

3.3.1.1. Review

As said above, this study is intended to be a review of other studies basically conducted through methods of interlinguistic sound perception. Notwithstanding, a comparative vowel inventory chart is shown below in figure 4 as a general overview. A Catalan vowel inventory chart and an English vowel inventory chart have been extracted from the home page of Jack Windsor Lewis (Lewis), one of

the most well-known British phoneticians, and they have been overlapped in order to compare and contrast vowel proximity between the vowel phonemes of both languages. It can also be seen the common areas shared by some of the sounds. The rounded vowels are represented by circles.

Figure 4. English and Catalan Vowel Charts overlapped (extracted from Jack Windsor Lewis home page and manipulated and ovelapped by Jaïr López Samit)



There is extensive literature on acoustic vowel charts, some of which is mentioned in the section of inventories, and therefore it is very difficult to determine a universal or unique vowel chart for each language. But if the chart proposed above is considered, it can be seen that Catalan /i/ and /u/ and English /iː/ and /uː/ are almost identical in quality. Catalan /e/, /a/, and /o/ share some space with English /e/, /ɑː/, and /ɔː/ respectively. Finally, Catalan /ɛ/, /ɔ/, /a/, and /e/ are close to English /æ/, /ɒ/, /ʌ/, and /ɪ/.

It is worth mentioning that, although in this chart English /ɜː/ and /ə/ are mapped differently, being /ə/ a bit opener than /ɜː/, in most English vowel inventories are mapped nearly together. Eva Estebas in her book *Teach Yourself English Pronunciation* (Estebas Vilaplana, 2016) states that English /ə/ “is similar in

quality to /ɜ:/ but is much shorter" and that "English /ə/ is close to Catalan vowel at the end of *hol<u>a</u>* or *mar<u>e</u>*" (Estebas Vilaplana, 2016, p.60). So English /ə/ and Catalan /ə/ are expected to be very similar.

However, according to figure 4 English /ɜ:/ is far from any Catalan phoneme as well as English /ʊ/. Thus, with regards to the models presented in section 3.1.1 English /i:/, /u:/, and /ə/ are almost identical (SLM) to Catalan /i/, /u/, and /ə/ respectively and will be perceived and pronounced with no significant differences by Catalan speakers.

On the other hand, English /æ/, /ɔ:/, and /ɒ/ are similar to Catalan /ɛ/, /o/, and /ɔ/, and the L2 sounds will be probably assimilated to L1 sounds (SLM). English /e ɪ/ and /ʌ ɑ:/ are similar to Catalan /e/ and /a/ respectively, being English /e/ and /ɑ:/ closer to L1 sounds and /ɪ/ and /ʌ/ poorer examples of L1 sounds, thus being two examples of Category-Goodness assimilation according to PAM.

And finally, English /ɜ:/ and /ʊ/ are new sounds that have no clear match in Catalan (SLM) and are expected to be perceived and produced by Catalan speakers with enough experience in L2. However, as said above, some researchers suggest that English /ɜ:/ is similar to English /ə/, and consequently, to Catalan /ə/.

As for perceptual proximity studies, Juli Cebrian, Associate Professor at the English Philology Department at *Universitat Autònoma de Barcelona* and one of the most well-known researchers in cross-linguistic phonetical studies between English and Catalan, in one of his researches (Cebrian, 2005) bidirectionally assessed the similarity between Catalan /i/, /e/, /ɛ/ and English /i/, /ɪ/, /e^{i}/, and /e/. It is worth noting that, in his papers dealing with Catalan and English vowels, Cebrian generally uses the symbol /ɛ/ instead of English /e/ for the sake of clarity, since he argues that English /e/ is a relatively open vowel sound, since there is a lack of contrast /e/-/ɛ/ in this language (Cebrian, 2019a, p.26).

This study was carried out by means of a Perceptual Assimilation Task (PAT) in which Catalan speakers had to identify English and Catalan vowels in terms of Catalan vowels, and English speakers had to identify English and Catalan vowels in terms of English vowels. The participants had to asses goodness ratings (GR) for each response in a Likert scale from 1 (bad exemplar) to 7 (good exemplar).

Although the stimuli were elicited from Canadian English speakers “the values do not differ noticeably from those of the other varieties” (Cebrian, 2006, p.375). Regarding L2 vowel production, a group of 8 English speaking listeners had to evaluate 30 Catalan advanced learners of English producing the vowels inserted in a /h_b/ word frame.

The results showed that English /i/ is perceptually identical to Catalan /i/ (99% identification and 6,2 GR), English /e/ and Catalan /ɛ/ are almost identical (93% identification and 4,2 GR), and that English /ɪ/ as Catalan /e/ (66% identification and 3,5 GR) and Catalan /e/ as English /ɪ/ (64% identification and 4,3 GR) fall outside the native fit index range. In terms of L2 production, Catalan /i/ and /ɛ/ pass as good instances of English /i/ and /e/ respectively, but Catalan /e/ do not. In addition, it is suggested that producing an accurate L2 English /ɪ/ involves the creation of a new vowel category.

In one of his articles, published in the Journal of Phonetics in 2006 (Cebrian, 2006), in which Cebrian studied the role of experience and vowel duration in non-native vowel categorisation, the same sounds, that is, English /i ɪ e e^{i}/ were measured through a PAT. The English vowels stimuli included British, North American, and Canadian varieties. The results were the same as those found in the previous paper: the “English vowel /i/ obtained the highest assimilation scores to Catalan /i/, the acoustically closest L1 vowel, and the highest goodness ratings”, indicating that the “two vowels are practically indistinguishable” (Cebrian, 2006, p.377).

On the other hand, vowel /ɪ/ “obtained the lowest assimilation scores to the acoustically closest Catalan vowel (/e/) and the lowest goodness ratings” (Cebrian, 2006, p.377). English vowel /e/ had also good both identification scores and goodnes ratings to Catalan /ɛ/. In relation to English /e/, Eva Estebas asserts that it “is similar to the Catalan sound in the words *pe<u>e</u>ra* and *me<u>e</u>l*”, that is, the Catalan sound /ɛ/ (Estebas Vilaplana, 2016, p.39).

In another of his researches (Cebrian, 2013), a study on perceptual proximity between English and Catalan vowels was conducted through a direct interlinguistic perceptual comparison, a Rated Dissimilarity Task (RDT), in which listeners compared the degree of similarity and dissimilarity between a pair of

acoustic stimuli of the two languages under study, and an indirect task (PAT) in which the stimuli of one of the languages were compared with the mental representations of the target language sounds by means of interlinguistic identification.

The results of the PAT indicated that English /i e æ/ had a high degree of identification with and high goodness ratings to Catalan /i ɛ a/, respectively; English monophthongs /ɒ ɔ u/ had a high degree of identification with and moderate goodness ratings to Catalan /ɔ o u/; English /ɪ ɑ ɜ ʌ/ had a low degree of assimilation to Catalan vowels and low goodness ratings; and , finally, English /i: ɪ/ and /æ ɑ ʌ/ were cases of multiple identification with Catalan /i/ and /a/ respectively. The results of the RDT showed the same tendencies as the PAT. English /i e æ/ and Catalan /i ɛ a/ respectively demonstrated no significant differences, so they can be classified as near-identical.

In 2019, Cebrian carried out a new comparative study the other way round, that is, a study on how L1 British English speakers perceive L2 Catalan vowels. This study was included in a chapter of the book *Eines per a l'aprenentatge del català com a L2 i LE* (Cebrian, 2019a). The study consisted of two tasks, a PAT and a RDT, conducted through 27 British English native speakers who were students at University College London (UCL). None of them spoke Catalan.

The results of these tasks suggested that Catalan /a ɛ/ are perceptually very close to English /æ e/ and that interlinguistic differences between them go unnoticed. Catalan /e/ is closer to English /ɪ/ than English /e/, but it has a lower degree of assimilation than Catalan /ɛ/. Catalan /i u/ are assimilated to English vowels in a lower degree than other vowels, but their peripheral position makes them easily assimilable to the corresponding English peripheral vowels /i: u:/. And finaly, regarding mid back vowels, both Catalan /ɔ o/ are assimilated to English /ɒ/.

Angélica Foresti Carlet in her PhD Dissertation (Foresti Carlet, 2017) reviewed the most important studies on cross-linguistic difficulties with vowels for L1 Catalan learners of L2 English. She concluded that English /ɜ:/ was the most dissimilar sound and, according to SLM and PAM, it was the best identified sound (Foresti Carlet, 2017, p.60); English /i:/ was "the most consistently assimilated to an L1 vowel", that is, to Catalan /i/; and that "the sounds that will pose more

difficulty for the learners will be /æ/-/ʌ/, since they will both be confused with the L1 sound (/a/)" (Foresti Carlet, 2017, p.61).

Another factor to take into account is the vowel inventory size of each language. In this sense, an article conducted by several authors (Souza et al., 2017) assessed the perception of English /i-ɪ/ by 66 learners of four different native languages: Danish, Portuguese, Catalan, and Russian. It was found that speakers of the language with the largest vowel inventory, the Danish, were those who showed the most accurate perception of English vowels, and that the speakers of the smallest L1 vowel inventory, Russian, basically relied on vowel duration to perceive English sounds. On the other hand, Catalan and Portuguese, which have a similar vowel inventory size, performed similarly. Thus some researchers defend the theory that "languages with large vowel inventories would have gained experience in tuning to small-scale spectral differences from their L1, making the perception of L2 vowels an easier task" (Souza et al., 2017, p.34).

As for the perception of English /i:-ɪ/ by Catalan learners of English, the results obtained were similar to those of previous studies: English /i:/ and Catalan /i/ were highly similar, whereas English /ɪ/ was more dissimilar from L1 sounds and could be perceived as either Catalan /e/, /i/, or /ɛ/.

The last study to be reviewed in this section is an article undertaken by the American linguist Jennifer Zhang (Zhang, 2019), in which she evaluated the feature-specific advantages in L3 phonological acquisition. Thus, she took as the object of her study both Catalan-Spanish and Basque-Spanish bilinguals who learned English as a L3. She asserted that "while the phonological system of Basque is similar to that of Spanish, Catalan and English share certain phones or contrasts that both Spanish and Basque lack" (Zhang, 2019, p.3740).

The results of the study were aligned with the others studied in the present section suggesting that English /i: e/ were very similar to Catalan /i ɛ/ and that English /ɪ/ was perceived as a poor match of Catalan /e/ and that productions of English /ɪ/ overlapped with /i/. It was also concluded that "L3 learners may therefore demonstrate an advantage only when phones are meaningfully contrastive in the L1/L2" (Zhang, 2019, p.3743).

3.3.1.2. Conclusions

Although most of the literature reviewed in the present section belongs to Juli Cebrian it is worth emphasising that his studies are conducted through different groups of participants, which makes it reliable. The fact that in all cases the direct (RDT) and indirect (PAT) perceptual tasks show similar results, further guarantees the reliability of his research. Thus, some conclusions can be drawn from the literature reviewed in the previous section.

Firstly, it can be concluded that English /iː/ is near-identical to Catalan /i/ and that although Catalan /ɛ/ is acoustically closer to English /æ/ than to English /e/, it is mostly perceived as English /e/, so they do not show significant differences of perception and production. On the other hand, although English /ɪ/ is acoustically closer to Catalan /e/ than English /iː/, in many occasions it is assimilated to Catalan /iː/; English orthography plays an important role in this process of assimilation.

It can also be held that Catalan speakers will have difficulties to distinguish English /æ ʌ ɑː/, being a case of multiple assimilation to Catalan /a/. However, some of the papers reviewed indicate that English /æ/ is mostly perceived as Catalan /a/. Despite not being identical sounds, English /uː/ is assimilated to Catalan /u/ probably due to its peripheral position.

The English contrast /ɔː-ɒ/ is believed to match the Catalan contrast /o-ɔ/. In spite of the fact that these English sounds are more open than those of Catalan, they are similar sounds and are expected to be mostly assimilated to their Catalan counterparts.

As for the central English vowel /ə/, although it is hardly taken into account in the literature reviewed, according to Eva Estebas (Estebas Vilaplana, 2016, p.60) it is very similar to Catalan /ə/, so it is expected to be easily both perceived and produced by Catalan speakers.

Finally, English /ɜː/ and /ʊ/ are mostly considered new sounds by the researchers included in the present paper so, theoretically, they can be learned and accurately perceived with enough exposure to L2 by Catalan speakers. However, as said above, some researchers consider that the quality of English /ə/ is similar to that

of Catalan /ə/ and the quality of English /ɜ:/ is similar to that of English /ə/ but longer in duration (Estebas Vilaplana, 2016). Therefore, it can be concluded that the quality of English /ɜ:/ will be similar to that of Catalan /ə/, so it is expected to be assimilated by Catalan speakers.

On another note, the research in which English speakers are tested to identify their perception of Catalan vowels (Cebrian, 2019a) show very similar results of identifcation with and assimilation to those of Catalan, what demonstrates once more the reliability of the research reviewed in the present paper in terms of vowel perceptual proximity.

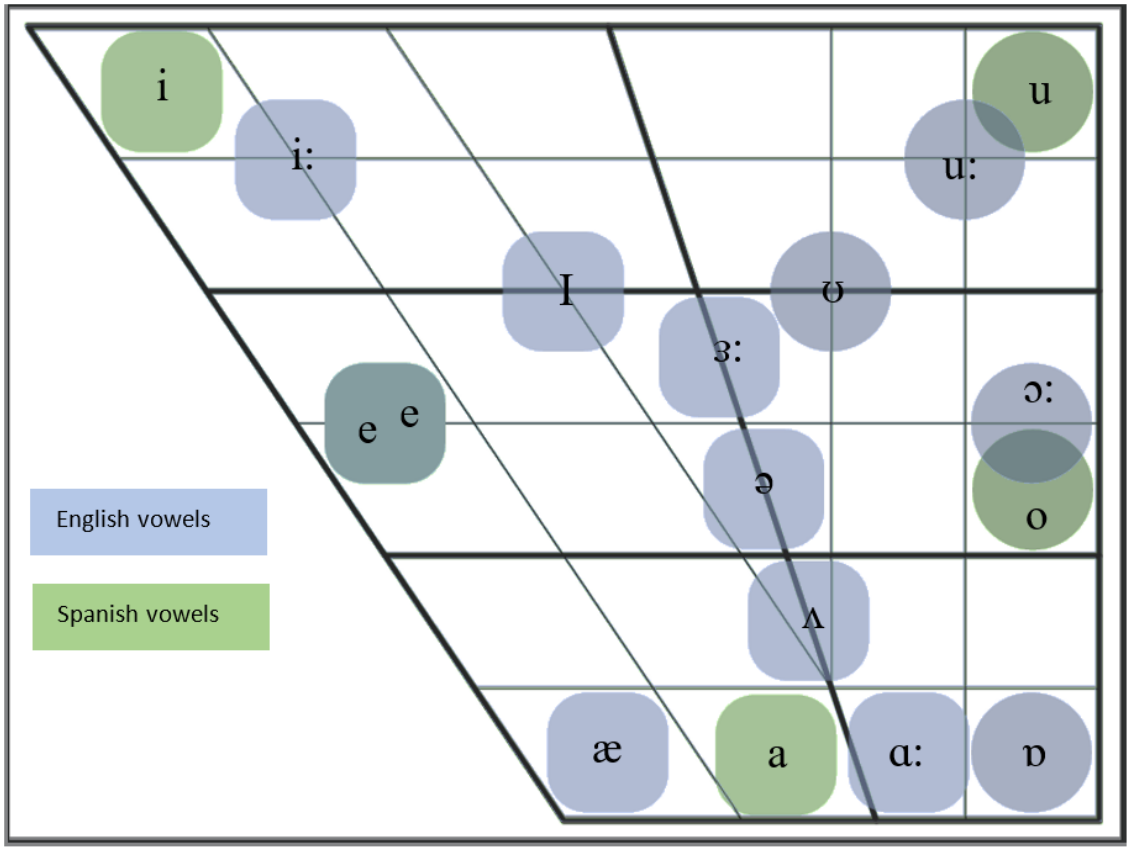
In summary, it can be concluded that Catalan L1 speakers will easily be able to perceive and produce similarly English /i: e u ə ɜ:/; that they will be able to perceive English /ʊ/ with enough experience in L2; that they will have some difficulties to perceive and produce accurate instances of English /ɔ: ɒ æ/; and that they will have serious difficulties in perceiving and producing English /ʌ ɑ: ɪ/. It is worth noting, eventually, that according to Jennifer Zhang Catalan speakers can be favoured by the fact of being bilinguals (L1 Catalan/L2 Spanish) when learning a L3.

3.3.2. English vs Spanish vowels

3.3.2.1. Review

In this section, as well as in the section devoted to English and Catalan vowel comparison, the English and the Spanish vowel inventories extracted from Jack Windsor Lewis home page (Lewis) have been mapped into a common vowel chart in order to have a general overview, as can be seen in figure 5.

Figure 5. English and Spanish Vowel Charts overlapped (extracted from Jack Windsor Lewis home page and manipulated and ovelapped by Jaïr López Samit)



According to figure 5, and being aware that this is merely one of many different vowel inventory charts, it can be inferred that English /e/ and Spanish /e/ are almost identical and English /ɔ: u/ share some common space with Spanish /o u/; Spanish /i a/ do not share any common space with any English vowel sound; and that the Spanish vowel inventory chart reveals a lack of sounds in the central vowel space of this language.

An extensive description of RP English vowels and a comparative analysis between them and the Peninsular Spanish ones can be found in chapter 3 of the

book *English Pronunciation for Speakers of Spanish* (González Gómez, María de los Angeles & Sánchez Roura, 2016). In section 3.2 of this book it is argued that, although none of the Spanish vowels exactly coincide with any of those of English, RP /i: e ɔ: u:/ can be considered near equivalents of Spanish /i e o u/. However, English /i: u:/ are more central than Spanish /i u/, English /e/ is more open than Spanish /e/, and English /ɔ:/ is closer than Spanish /o/. In contrast, it is predicted that Spanish speakers must have serious difficulties in perceiving and producing RP /ə ɜ: ɪ ʊ ɒ/. Similarly, the English contrasts /i:-ɪ/, /e-æ/, and /æ-ʌ/ have been found to be problematic for them. It is also mentioned that English vowels are generally higher in F_2 than those of Spanish.

According to the authors of this book Spanish speakers tend to classify the English vowels into five groups depending on the vowel space they occupy. In Group 1 the RP /i: ɪ/ are connected to Spanish /i/. RP /i:/ is slightly closer than Spanish /i/, whilst RP /ɪ/ is closer and more retracted, being, thus, spectrally different. It is also maintained that Spanish learners of English tend to assimilate both English sounds to Spanish /i/.

In Group 2 RP /e ɜ: ə/ are linked to Spanish /e/. Spanish /e/ is closer to RP /e/ than to RP /ɜ:/. RP /e/ is mapped halfway between Spanish /e/ and /a/ for F_1 but closer to Spanish /e/ for F_2. English /e/ is a bit more open and retracted. It is worth mentioning that the authors highlight the fact that /ɜ:/ and /ə/ are the most dissimilar English vowels for Spanish speakers. In accordance with NML, when a certain sound of L2 is dissimilar to a sound of L1, the magnet effect remains inactive and does not affect the L2 perception, so it is therefore easier to discriminate the L1 sound from the L2 sound. Therefore, English /ə ɜ:/ should be easily perceived by Spanish learners of English.

By contrast, the authors of the book affirm that experimental research confirms the Error Analysis prediction for these central vowels, since they perform many wrong identifications due to assimilations with all Spanish vowels. The Error Analysis theory postulates that when the learner is engaged "in a process of discovering a language" he or she "forms hypotheses based on language input and tests those hypotheses in speech production" (Lennon, 2008, p.4). In this sense, it is expected to be difficult for Spanish speakers to pronounce English /ə/ and /ɜ:/.

In Group 3 RP /æ ʌ ɑ:/ are bound to Spanish /a/. RP /ʌ/ is very similar in quality to Spanish /a/, but it is shorter and more different than English /ɑ:/, so RP /ʌ/ is not usually perceived as a protoypical Spanish /a/ by Spanish speakers because it is more central and closer than Spanish /a/. On the other hand, English /æ/ is perceived as a sound halfway between Spanish /a/ and /e/. Returning to RP /ɑ:/, it is more open than RP /ʌ/. In spite of the fact that this sound is the closest to the Spanish /a/ in terms of formants, when it is produced the tongue is more retracted than in the case of Spanish /a/ and it will present difficulties for Spanish learners to perceive and produce this sound accurately. It is also remarked that out of the three RP sounds of this group, /æ/ is the one that is more highly assimilated to Spanish /a/.

In Group 4 RP /ɔ: ɒ/ are related to Spanish /o/. Spanish /o/ is halfway between RP /ɔ:/ and /ɒ/, being more open than English /ɔ:/ and closer than English /ɒ/. Nevertheless, both RP sounds tend to be assimilated to Spanish /o/.

And to finish the review of this book, in Group 5 RP /u:/ and /ʊ/ are linked to Spanish /u/. RP /u:/ is closer and more lip-rounding than Spanish /u/, and RP /ʊ/ is more open than Spanish /u/. Both English sounds tend to be identified by Spanish speakers as Spanish /u/, and it is predicted by the authors that it will be hard for Spanish learners of English to distinguish these sounds.

As for perceptual proximity studies, Juli Cebrian, in one of his articles published in the *Journal of the Acoustical Society of America* (Cebrian, 2019b), carried out research in which 29 participants performed two vowel identification tasks in order to examine the perceived similarity between SSBE and Spanish monophthongs and diphthongs. In the first PAT, the one that is of interest for the purpose of this review, the participants had to listen to an English vowel stimulus and identify it as a possible L1 category. They also provided a GR for each sound in a Likert scale from 1 (poor example) to 7 (good example).

A total of 112 trials were conducted and the results showed that SSBE /i:/, /e/, /æ/, and /ʌ/ had a high degree of identification and high values of GR for the Spanish /i/ (99% id., 5,8GR), /e/ (98% id., 5,6 GR), /a/ (99% id., 5,5 GR), and /a/ (97% id., 5,4 GR). All these English vowels are thought to be produced and perceived in terms of their L1 counterparts. English /u:/ had a high degree of

identification with Spanish /u/ (96% id.), but a moderate value for GR (4,9). SSBE /ɑ:/, /ɜ:/, /ɒ/, and /ɔ:/ showed a moderate identification with Spanish /a/ (75% id., 4,5 GR), /e/ (62% id., 3,0 GR), /o/ (75% id., 5,2 GR), and /o/ (85% id, 4,3GR). English /æ/ and /ʌ/ were considered as an example of a single-category (SC) assimilation (PAM-L2), both assimilated to Spanish /a/, so it was predicted that it will be very difficult for Spanish speakers to differentiate the sounds of this L2 contrast. It is also the case with SSBE contrast /ɔ:-ɒ/, in which both sounds will be assimilated to Spanish /o/.

English /ɑ:/ was found to be assimilated to Spanish /a/, but with a lower degree than /æ/ and /ʌ/. Then, the English contrasts /ɑ:-æ/ and /ɑ:-ʌ/ could be considered as instances of category-goodness (CG) assimilation (PAM-L2), so they are expected to be better distinguished than the pair /æ-ʌ/ (SC).

The research of this article also predicted that SSBE /e/ and /ɪ/ assimilate to Spanish /e/, but in different degrees (/e/ 98% and /ɪ/ 59%). However, it was argued that English /ɪ/ was mostly assimilated to Spanish /i/, probably due to the influence of orthography. The results of the tasks undertaken in this study also showed that English /ʌ/ and /ɜ:/ are sometimes perceived as Spanish /o/.

In an article also published in the *Journal of the Acoustical Society of America* (Escudero & Chládková, 2010), Paola Escudero and Katerina Chládková conducted a study in order to try to demonstrate that the dialect to which L1 learners of L2 are exposed plays an essential role in vowel perception. They assessed the categorisation of SSBE and American English (AE) vowels by Spanish learners in their initial stages.

The research was carried out through a PAT in which the participants had to identify the English sounds in terms of the Spanish vowels. The results of the task showed a high degree of identification of SSBE /i: e æ ɔ ʊ u:/ with the Spanish /i e a o u u/ respectively. The results of the task also showed that SSBE /ɪ/ was identified with Spanish /u/ (41%), /e/ (35%), and /i/ (21%), which suggests great difficulty for Spanish learners to discriminate these sounds. It is also the case with English /e/, which was mostly identified as Spanish /e/ (77%), but also with /o/ (7%), and /u/ (13%).

The English /ɑ:/ was similarly identified with Spanish /a/ and /o/, what predicts great difficulty of discrimination for learners. English /ʌ/ was identified as Spanish /a/ (74%) and /o/ (23%), showing that Spanish learners will have some difficulties to discern one English vowel from the other.

In an article focused on teaching English vowels to Spanish speakers (del Puerto & Lacabex, 2008), Francisco Gallardo and Esther Gómez argue that English and Spanish vowels do not coincide in terms of quality, although some of them are near. According to them, English /i: e ɔ: u:/ could be considered to be nearly equivalent to Spanish /i e o u/. However, English /i:/ and /u:/ are a bit closer than Spanish /i/ and /u/, English /e/ is more open than Spanish /e/, and English /ɔ:/ is closer than Spanish /o/.

They affirm, as well, that Spanish does not have weak central vowels similar to English /ɜ: ə ɪ ʊ/. On the other hand, it is argued that the space occupied by English /ɒ ɑ:/ is empty in the Spanish vowel inventory. Thus, according to this study English /i: ɪ/ are assimilated to Spanish /i/; English /e ɜ:/ are assimilated to Spanish /e/; English /ə/ is assimilated both to Spanish /e/ and /a/; English /æ ʌ ɑ:/ are assimilated to Spanish /a/; English /u: ʊ/ are assimilated to Spanish /u/; English /ɒ/ is assimilated to both Spanish /o/ and /a/; and finally, English /ɔ:/ is assimilated to Spanish /o/.

In another journal article (Iverson & Evans, 2009), the learning of English vowels was assessed in terms of different L1 vowel systems. The research was intended to find out if L1 inventory size plays an important role in L2 vowel perception and production. A language with a large vowel inventory, German, and a language with a small vowel inventory, Spanish, were the object of study of this research.

The participants of both languages were tested before and after training English vowel sounds in a vowel identification task. The results showed that German speakers improved more than Spanish speakers, in spite of the fact that German has a more crowded vowel inventory space. Thus it was concluded that “a larger category inventory may facilitate new learning” (Iverson & Evans, 2009, p.866).

The results of the task of vowel identification for Spanish (it has been taken into account the values obtained before the participants’ training, because they show the difficulties found by learners without experience in L2 more clearly) showed

that English /i: e ɒ ɔ: u:/ had high percentages of identification with Spanish /i e o o u/, respectively; English /ɪ ʌ ɑ:/ had moderate percentages of identification with Spanish /i a a/ respectively; and English /ɜ:/ had a low percentage of identification with Spanish /e/.

The last paper to be reviewed in this section is included in the conference proceedings of the 15th International Congress of Phonetic Sciences held in Barcelona in 2003 (Morrison, 2003) in which the author conducted a study the other way round, that is, a study on how L1 English speakers perceive and produce Spanish vowels as a L2. Although the perceptual results were obtained from Canadian speakers, the results would not differ much from those of British English, as said above. The English speakers had to identify Spanish vowels in terms of English categories.

The results showed that the listeners identified Spanish /i e o/ with English /i: e ɔ:/ respectively, and perceived Spanish /a/ as multiple-category assimilation to English /æ ʌ ɒ e/, as well as Spanish /u/ to English /u: ʊ/. As for the production, it was suggested that English speakers produced English /i: e æ ɔ: u:/ for Spanish /i e a o u/.

3.3.2.2. Conclusions

Some conclusions can be drawn from the research reviewed in the previous section. To begin with, it is clear that no Spanish vowel exactly coincides with any of those of English, although some of them are near. Another aspect in which all the researchers agree is that the Spanish vowel chart is empty in the central space, that is, it only includes peripheral categories.

Thus, according to the models analysed in section 3.1.1., one could predict that English central sounds such as /ɜ: ə ʊ/, which are far from any Spanish vowel, would be easily discriminated by Spanish learners of English. However, as it is argued in the book *English Pronunciation for Speakers of Spanish* (González Gómez, María de los Angeles & Sánchez Roura, 2016), the Error Analysis theory predicts that the lack of these sounds in the Spanish inventory will have the opposite effect. In this sense, most of the papers reviewed show that English /ɜ:/, for instance, is sometimes perceived as Spanish /e/ and others as Spanish /o/, which, in a way, support this theory, at least, for unexperienced learners.

It is also clear that English /i: e ɔ: u:/ are typically identified with Spanish /i e o u/, whilst English /æ ʌ ɑ:/ is a case of multiple-category assimilation which predicts some difficulties in discriminating these three English sounds for Spanish speakers.

It is important to note that the studies which have been examined also prove that Spanish learners of English are mostly in line with the classification into five groups of vowels proposed by María de los Ángeles Gómez and Teresa Sánchez (González Gómez, María de los Angeles & Sánchez Roura, 2016). Thereby, English /i:/ is highly assimilated to Spanish /i/. On the other hand, English /ɪ/ in spite of being spectrally different from both English /i:/ and Spanish /i/, is generally assimilated to Spanish /i/ as well, mainly due to the influence of English orthography. Then, it will be difficult for Spanish learners to perceive accurately English /ɪ/. English /e/, although it is a bit more open than its Spanish counterpart, will be a good instance of Spanish /e/.

Regarding the English central vowels /ɜ: ə/, as stated above, they are expected to be difficult to be perceived and produced by L1 Spanish. The English vowel which is better perceived as Spanish /a/ is /æ/, although Spanish learners will have serious problems in discriminating the members of the contrasts /æ-ʌ/, /æ-ɑ:/, and /ʌ-ɑ:/.

As for the English contrast /ɔ: ɒ/, Spanish speakers tend to assimilate both sounds to Spanish /o/. Therefore, it will be very difficult for Spanish learners of English to discriminate these English sounds. The same goes for /u:-ʊ/ English contrast. Both sounds are mostly assimilated to Spanish /u/ and it will be hard for Spanish learners to perceive and produce accurately English /ʊ/.

It is worth mentioning that the research in which English speakers are tested to identify their perception of Spanish vowels (Morrison, 2003) shows very similar results of identifcation with and assimilation to Spanish sounds, which further proves the reliability of the literature that has been discussed in terms of vowel perceptual proximity.

Another point to be considered is the study in which it was concluded that languages with large vowel inventories facilitate the learning of a L2. The fact that

Spanish language has a relatively small vowel inventory can be considered a hindrance to learning a L2.

To sum up, it can be concluded that Spanish L1 speakers will easily be able to perceive and produce English /i: e u:/ as good instances of the target language; they will have some difficulties to perceive and produce accurate instances of /ɔ: æ/; and that they will have serious difficulties in perceiving and producing English /ʌ ɑ: ɪ ʊ ɜ: ə ɒ/.

4. Final Conclusions

The main goal of this paper was to determine the similarities and dissimilarities between English, Catalan, and Spanish vowel perception and production. In this sense, the initial hypothesis was that it would be easier for Eastern Catalan L1 Speakers than for L1 Spanish speakers to perceive and pronounce RP (or SSBE) English vowels. In order to carry out this research, three speech models, namely NLM, PAM and SLM, have been described in the first section of the development to analyse how interlinguistic vowel similarities and dissimilarities can weigh on the perception and production of L2 vowel sounds by L1 speakers. Later, the most common methods of acoustic measurement and perception by which researchers conducted their studies have also been seen. The inventories of the three languages have been shown and several cross-linguistic studies between English and Catalan and Spanish vowels have been reviewed in order to ascertain vowel proximity.

The final conclusions drawn from the review of these comparative interlinguistic studies between English-Catalan and English-Spanish vowels corroborate the initial hypothesis, that is, that it will be a little easier for L1 Catalan learners of L2 English than for L1 Spanish learners of L2 English to perceive and produce the vowels of the target language. These conclusions are based on three main aspects.

The first aspect is related to the lack of central vowels in the Spanish vowel inventory. The models studied in section 3.3.1. assert that when a L2 sound is different from an L1 sound it is easier to be discriminated by L1 speakers. However, in the book *English Pronunciation for Speakers of Spanish* (González Gómez, María de los Angeles & Sánchez Roura, 2016) it is argued that according to the Error Analysis theory English central vowels tend to assimilate to multiple L1 vowels instead of being categorised as new sounds by Spanish learners, at least by beginners. This theory seems to be mostly supported by the literature assessed in section 3.3.2.1, which shows that English /ɜ:/ is mostly assimilated to Spanish /e/ and /o/. By contrast, the Catalan vowel inventory has the central vowel /ə/ which is similar in quality to English /ə/ and /ɜ:/. In this way, Spanish speakers are expected to perceive and produce English /i: e u:/ as good instances of L2 sounds as well as Catalan speakers, but English /ə/ and /ɜ:/ must be added

to the latter as good examples. Then, Catalan learners are expected to perceive and produce good instances of five English vowels, while Spanish speakers are expected to do it with only three.

The second aspect is connected to vowel inventory size. Two researches reviewed in this paper, one in the section of English vs Catalan vowels (Souza et al., 2017) and the other in the section of English vs Spanish vowels (Iverson & Evans, 2009), maintain that the larger a vowel inventory size of a language is, the easier it will be for their speakers to perceive L2 categories. As Catalan vowel inventory is larger than that of Spanish, it is expected to be easier for Catalan speakers to discriminate more accurately English sounds.

The third aspect is linked to bilingualism. It is a fact that all L1 Catalan speakers are bilinguals, so they speak Catalan and Spanish as well. However, not all L1 Spanish speakers are bilinguals. In this respect, according to the Jennifer Zhang article reviewed in section 3.3.1.1, speakers of L1 can be favoured by the fact of being bilinguals when learning a L3 (in this case English), as long as some L1 and L2 phones can be significantly contrasted. That is the case of Catalan mid vowels, which can be contrasted with Spanish mid vowels. In other words, Spanish only has one front mid vowels (/e/) and one back mid vowel (/o/), whilst Catalan have two front mid vowels (/e/ and /ɛ/) and two back mid vowels (/o/ and /ɔ/). In addition, as seen above, Catalan inventory includes a central vowel /ə/, whilst the central space of the Spanish inventory is empty.

To conclude, the literature reviewed in the present paper suggests that what makes the difference between Catalan and Spanish perception and production of English vowels is the presence of the contrast in mid vowels /e-ɛ/ and /o-ɔ/, and the central vowel /ə/, since high and low vowels of Catalan and Spanish inventories present similar difficulties of perception and production of the English sounds. Regarding high vowels, Catalan and Spanish /i/ and /u/ are well matched to English /i:/ and /u:/; and as far as low vowels are concerned, English /ʌ ɑ: æ/ will be very difficult to be distinguished both by Catalan and Spanish learners of English.

It is important to remark that the present study is limited by time constraints and by the fact that it is only devoted to monophthongs in isolation. Nevertheless, it

may be useful for further research. For instance, a similar descriptive or empirical research that includes vowels in company or diphthongs, or that takes into account vowel length and/or speakers' experience in L2 could be carried out in the future.

5. Bibliography

Baugh, A. C. (2013). In Cable T. (Ed.), *A history of the English language* (6th ed.). London: Routledge.

Best, C. T., & Tyler, M. D. (2007). Non-native and second-language speech perception: Commonalities and complementarities. *Language Experience in Second Language Speech Learning: In Honor of James Emil Flege, 1334*, 1-47.

Boersma, P., & Weenink, D. Praat: Doing phonetics by computer. http://www.praat.org/

Borden, G. J. (2011). In Harris K. S., Raphael L. J. (Eds.), *Speech Science Primer: Physiology, Acoustics and Perception of Speech* (6th ed.). Philadelphia: Wolters Kluwer, Lippincott Williams and Wilkins.

Bradlow, A. R. (1995). A comparative acoustic study of English and Spanish vowels. *The Journal of the Acoustical Society of America, 97*(3), 1916-1924.

Catalá, M. C. (1994). Aspectes contrastius de la fonètica i fonologia catalana i anglesa. *Sintagma: Revista De Lingüística, 6*, 15-21.

Cebrian, J. (2005). Measuring phonetic distance between Catalan and English vowels: A bidirectional cross-language mapping study. Paper presented at the *2nd Phonetics and Phonology in Iberia Conference.* Universitat Autònoma De Barcelona, Spain.

Cebrian, J. (2006). Experience and the use of non-native duration in L2 vowel categorization. *Journal of Phonetics, 34*(3), 372-387.

Cebrian, J. (2013). Proximitat perceptiva i aprenentatge de vocals angleses i catalanes.Retrieved from

https://www.recercat.cat/bitstream/handle/2072/216606/2009PBR00008.pdf?sequence=1

Cebrian, J. (2019a). Percepció de vocals catalanes per part d'anglòfons: Similitud interlingüística i conseqüències per a l'aprenentatge. In C. Pons-Moll, J. Carrera-Sabaté, J. Bach Marques, M. Busquets de Jover & L. Jiménez Torres (Cord.), *Eines per a l'aprenentatge del català com a L2* (1ª ed., pp. 23-35). Barcelona: Graó.

Cebrian, J. (2019b). Perceptual assimilation of British English vowels to Spanish monophthongs and diphthongs. *The Journal of the Acoustical Society of America, 145*(1), EL52-EL58. doi:10.1121/1.5087645

Chacón Beltrán, R. (2017). *Sociolinguistics* (1ª ed., 1ª reimp.). Madrid: Universidad Nacional de Educación a Distancia.

Cruttenden, A. (2014). *Gimson's pronunciation of English* (8th ed.) Routledge.

del Puerto, F. G., & Lacabex, E. G. (2008). La enseñanza de las vocales inglesas a los hablantes de español. *PULSO.Revista De Educación,* (31), 37-66.

Escudero, P., & Chládková, K. (2010). Spanish listeners' perception of American and Southern British English vowels. *The Journal of the Acoustical Society of America, 128*(5), EL254-EL259. doi:10.1121/1.3488794

Estebas Vilaplana, E. (2016). *Teach Yourself English Pronunciation: An Interactive Course for Spanish Speakers* (1ª reimp. ed.). Oleiros (La Coruña). Netbiblo, Madrid: Universidad Nacional de Educación a Distancia.

Flege, J. E. (1995). Second language speech learning: theory, findings, and problems. *Speech Perception and Linguistic Experience: Issues in Cross-Language Research, 92*, 233-277.

Flege, J. E. (2006). L2: Phonetics and honology. Speech learning. Retrieved from http://www.jimflege.com/index.html

Flege, J. E. (2007). Language contact in bilingualism: Phonetic system interactions. In J. Cole, & J. I. Hualde (Eds.), *Laboratory phonology* (pp. 353-381). Portland: Mouton de Gruyter.

Flege, J. E. (2015). Origin and development of the speech learning model. Retrieved from http://www.jimflege.com/files/SLMvancouver_updated.pdf

Flynn, N. (2011). Comparing vowel formant normalisation procedures. *York Papers in Linguistics, 2*(11), 1-28.

Foresti Carlet, A. (2017). In Cebrian J. (Ed.), *L2 perception and production of English consonants and vowels by Catalan speakers: The effects of attention and training task in a cross-training study.*

González Gómez, María de los Ángeles, & Sánchez Roura, M. T. (2016). *English Pronunciation for Speakers of Spanish: From Theory to Practice* (1st ed.) Boston; Berlin : De Gruyter Mouton. Retrieved from https://dialnet.unirioja.es/servlet/extlib?codigo=683032

Institut Ramon Llull. Retrieved from https://www.llull.cat/catala/recursos/llengua_catala.cfm

Instituto Cervantes. Retrieved from https://www.cervantes.es/sobre_instituto_cervantes/prensa/2019/noticias/presentacion_anuario_madrid.htm

Iverson, P., & Evans, B. G. (2009). Learning English vowels with different first-language vowel systems II: Auditory training for native Spanish and German speakers. *The Journal of the Acoustical Society of America, 126*(2), 866-877.

Jeske, A. (2012). *The Perception of English vowels by native Spanish Speakers.* Retrieved from http://d-scholarship.pitt.edu/13199/1/ARJ_Masters_Thesis_ETD_Format.pdf

Kuhl, P. K., & Iverson, P. (1995). Linguistic experience and the “Perceptual Magnet Effect”. *Speech Perception and Linguistic Experience: Issues in Cross-Language Research*, 121-154.

Lennon, P. (2008). Contrastive analysis, error analysis, interlanguage. *Bielefeld Introduction to Applied Linguistics.A Course Book.Bielefeld: Aisthesis Verlag.*

Lewis, J. W. Jack Windsor Lewis home page. Retrieved from

http://www.yek.me.uk/vowels.html

Martínez Celdrán, E. En torno a las vocales del español: Análisis y reconocimiento. Retrieved from

file:///C:/Users/Jair/Downloads/144415-Text%20de%20l'article-256957-1-10-20100614%20(2).pdf

Morales, S. P. (2007). Identificació de les vocals tòniques del català. *Phonica, 3*

Morrison, G. S. (2003). Perception and production of Spanish vowels by English speakers. Paper presented at the *Proceedings of the 15th International Congress of Phonetic Sciences: Barcelona,* 1533-1536.

Planas, A. M. F. (1993). Estudio del campo de dispersión de las vocales castellanas. *Estudios De Fonética Experimental, 5*, 129-162.

Rallo Fabra, L. (2008). In Lorenzo-Modia, María Jesús (ed. lit.), Alonso-Giráldez, J. Miguel (ed. lit.), Amenedo Costa, Mónica (ed. lit.), Cabarcos-Traseira, María J. (ed. lit.) and Lasa-Alvarez, Begoña (ed. lit.)(Eds.), *Can late EFL learners attain nativelike pronunciation? Evidence from Catalan speakers' production of English low vowels* (1st ed.) Universidade da Coruña, Servizo de Publicacións. Retrieved from

https://dialnet.unirioja.es/servlet/articulo?codigo=4941000&orden=0&info=link

Recasens i Vives, D. (2014). *Fonètica i fonologia experimentals del català: Vocals i consonants.* Institut d'Estudis Catalans.

Rius-Escudé, A. (2016). *Les vocals del català central en parla espontània.* Retrieved from

http://diposit.ub.edu/dspace/bitstream/2445/101605/1/ARE_TESI.pdf

Roach, P. (2004). British English: Received Pronunciation. *Journal of the International Phonetic Association, 34*(2), 239-245.

Schiller, N. O., & Meyer, A. (2003). *Phonetics and Phonology in Language Comprehension and Production: Differences and Similarities*. Berlin: Mouton de Gruyter.

Schouten, A. (2015). The Critical Period Hypothesis: Support, Challenge, and Reconceptualization. *Working Papers in Applied Linguistics and TESOL, 9*(1), 1-16. doi: 10.7916/D82V2TPX

Souza, H., Carlet, A., Jułkowska, I., & Rato, A. (2017). Vowel inventory size matters: Assessing cue-weighting in L2 vowel perception. *Ilha do Desterro, 70*(3), 33-46. doi:10.5007/2175-8026.2017v70n3p33

Thomas, E. R., & Tyler Kendall. (2007). NORM: The vowel normalization and plotting suite. Retrieved from

http://lingtools.uoregon.edu/norm/norm1.php

Trudgill, P. (2017). *International English: A Guide to Varieties of English around the World* (6th ed.). London; New York: Routledge, Taylor & Francis Group.

Vives, D. R. (2008). Mètodes de normalització i de representació de dades acústiques i articulatòries. *Estudios De Fonética Experimental, 17*, 332-341.

Wikipedia.Spanish vowel chart. Retrieved from

https://es.wikipedia.org/wiki/Archivo:Spanish_vowel_chart.svg#file

Zhang, J. (2019). Feature-specific advantages in L3 phonological acquisition. In S. Calhoun, P. Escudero, M. Tabain & P. Warren (Eds.), *Proceedings of the 19th international congress of phonetic sciences* (pp. 3740-3744). Canberra, Australia: Australasian Speech Science and Technology Association Inc.