University of Iceland

School of Humanities

Department of English

The Perception of lax-tense contrasts in English by Polish, Italian, Spanish L1 speakers residing in Australia

MA Essay

Katarzyna Dorota Zaorska

Kt.: 22111989-4779

Supervisor: Pétur Knútsson

May 2015

Contents

Abstract

The aim of this study was to examine the strategies used by L2 learners of Australian English for discriminating between the members of English contrasts that are absent in their L1 and to assess the effect of time of residence and level of education. Three different contrasts /oː/ - /ɔ/ (caught - cot), /iː/ - /ɪ/ (leave – live), /ɐː/ - /ɐ/ (Bart - but) were tested. A group of 18 Poles, 17 Italian and 15 Spanish speakers living in Australia participated in the study. Three different language groups were chosen in order to examine whether all of the informants use the same strategies for vowel identification when discriminating between the members of the tested contrasts. The study revealed that while generally all of the informants seem to add different phonetic cues when perceiving the lax-tense contrasts, they also tend to rely more on the durational cue rather than spectral property. When compared by language groups, the participants could be seen to apply different strategies. Moreover, those strategies differed in a particular language group in different tasks, which indicated that the participants' L2 perception system is still dynamic and has not stabilized. Furthermore, the results show that while the level of education has a positive effect on the discriminative ability between members of the tested contrasts, the time of residence does not have a great impact. This suggests that there must be other essential factors for L2 phonology acquisition which have not been explored in this study.

1. Introduction

As the literature on the participant clearly illustrates, humans attune to specific language stimuli that function in a language. L2 learners are able to learn new speech segments that do not exist in their L1, but the perception and production is often not identical with the native model. Due to their smaller vowel inventories, Polish, Italian and Spanish L1 speakers when perceiving English vowels may categorize non-native speech sounds as diaphones of the closest phoneme in their native phonemic inventory. It is generally accepted that non-native segments are perceived according to their similarities to and discrepancies from native sounds. Best (1995) has proposed the Perceptual Assimilation Model (PAM), according to which similarity between non-native and native segments determines a listener's "perceptual assimilation of non-native segments to native categories" (:193). The more similar they are, the more they are assimilated with the closest L1 segment.

Moreover, since the participants in their native language do not distinguish between tense vs. lax vowels, they are predicted to have difficulties differentiating between these contrasts. Escudero (2005) introduces the most elaborated L2 perception model so far, the Second Language Linguistic Perception Model (L2LP) which depicts the process of acquiring L2 phonetics and phonology. L2LP applies to both non-experienced and experienced L2 listeners. According to Escudero, the participants when acquiring the lax-tense distinction in English are facing the *new scenario* (Escudero, 2005:123) learning in which they perceive fewer categories than the L2 represents. Their L1 perception grammar contains fewer categories and therefore it could lead to two distinct phonemes being perceived as one L1 sound. The representational task here is to recognize new sounds as distinct phonemes. According to L2LP, the new scenario is more difficult than other two learning scenarios, since it requires a learner not only to create new categories and their perceptual mapping but also to integrate those new dimensions with already- categorized dimensions.

While both length and spectral differences are essential for vowel identification, it has been demonstrated that spectral information plays a primary role in vowel perception for native English speakers, and length just secondary one (Hillenbrand, 2013:26). However, different patterns were recognized in non-native perception of English vowels by Spanish and Russian L1 speakers. Spanish and Russian speakers rely primarily or even in some cases exclusively on length when identifying sounds from a tense-lax contrast (Kondaurova & Francis, 2008:3969).

This study aims to investigate what strategies are adopted by the participants for the discrimination between the members of lax-tense contrasts. Three different contrasts were used: the

contrast /ɐ:/ - /ɐ/ (Bart - but) which varied only in length, /i:/ - /ɪ/ (leave - live)which varied in length and tenseness, and /o:/ - /ɔ/ (caught - cot) which varied in length, tenseness and height. Those three different contrasts were tested in order to examine whether the participants depend on the same or different specific properties when discriminated the research vowels. The study also aimed at establishing whether all the three language groups used the same or different strategies when perceiving the lax-tense contrasts.

The thesis is arranged as follows. After the introduction, the subject literature will be reviewed in Chapter 2. Chapter 3 contains a description of the research methodology. Chapter 4 presents the statistical results of the test. This will be followed by a discussion of the findings in Chapter 5 and finally, Chapter 6 will draw conclusions.

2. Literature Review

2.1. The perception and production of L1 sounds.

There have been numerous studies devoted to the perception of native and non-native sounds (cf. Strange, 1995). From various psychoacoustic studies, it has been shown that when children interact with their linguistic environment during the acquisition of an L1, they "lose" the ability to perceptually differentiate phonetic categories that are not phonologically distinctive in their native language, while the L1 contrasts become highly differentiated (Werker & Tees, 1984). At the beginning of life infants can discriminate universal phonetic contrasts; however together with their language experience this ability decreases (Werker & Tees, 1984:49). As Werker and Tees explain, young infants respond to the present speech sound stimuli which are in accordance with the set of adult phonemes in a particular language, rather than master phonetic differences between the present sounds (1984: 49).

According to Best (1994), during the early months of an infants' life, perception of native and non-native phonetic contrasts is not largely dependent on the ambient L1, and this may reflect general linguistic abilities that are not yet constrained by a mother language (174). However, in the second half-year of life the perception of segments eventually become to be influenced by L1 and Best argues that this happens the phonetic gestures of their ambient language, so they can learn to speak their L1 (Best, 1994:173).The process of attuning to the language of the environment and establishing appropriate perception categories for the meaningful phonetic units in that language when infants start to recognize that L1 speech sounds are structured and "recurring constellations" or "patterns of coordination among phonetic-articulatory gestures" (Best 1994:168). Best emphasizes that infants must learn to perceive is guiding their production, allowing them eventually to reproduce those sounds (173). From the studies on consonantal and vowel vocalic contrasts studies, it can be concluded that language- specific patterns of perception are established in the first year of life, long before children have mastered how to produce them. Six-month olds infants can differentiate many non-native place and voicing contrasts for consonants that twelve-month olds cannot anymore; four-month olds differentiate non-native contrasts in vowels better than six-month olds who scored significantly higher than twelve-month-old infants. This also suggests that language-specific patterns of selective perception begin earlier for vowels than for consonants (Strange, 1995:30).

Languages differ in their phonemic contrasts which are "used systematically to convey differences in word meaning" (Best, 1994:176). Thus, L1 English speakers will establish different perceptual categories, for example, /l/ and /r/ since these are two distinct phonemes in that language,

while Japanese or Korean speakers will have great difficulties in hearing the difference between this liquid consonantal contrast due to the fact that it is absent in their native language. However, even if the language may share a particular phonemic contrast, the phonetic realization is often different in the articulatory details (Best, 1994:169). Languages may also share the same phoneme which will most likely vary phonetically between them, such as /r/, which is realized in American English as [ɹ] and in Spanish as [ɾ] or [r]. Therefore, languages use a subset of phonetic gestures and they differ in how they relate them to phonemic distinctions (Best, 1994:169).

Best also notes that infants must learn to perceive the phonetic gestures of their ambient language, so they can learn to speak their L1 (Best, 1992:173).The process of attuning to the language of the environment and establishing appropriate perception categories for the meaningful phonetic units in that language guides their production, allowing them eventually to reproduce those sounds (Best, 1992:173).

The Native Language Magnet model (NLM) (Kuhl & Iverson, 1995) attempts to outline developmental changes in auditory vowels and consonants from a universal to a language- specific perception during the first year of life. Infants attune their phonetic perception to the linguistically functional contrasts and establish phonological categories that reflect the distributional properties of the ambient language. One of the model's premises is that a prototype category behaves as a magnet and drags similar sounds towards it, decreasing closer ones to the prototype and at the same time increasing sensitivity to cross-category differences. This also applies to cross-language studies, where similar non-native sounds are pulled in to the native prototypes (Smiljanic, 2011:424).

It must be noted that the development of L1 phonology, according to Best, is different from the acquisition of L2 phonology. As discussed earlier, infants are born with universal abilities for the discrimination of phonetic contrasts; however in the first months of their life they begin to establish perceptual categories for the sounds that are distinctive in the ambient language. The acquisition of L2 phonology, however, is quite different, especially for adults. L1 phonology has a great influence on an adult's L2 phonology since in most cases they maintain their native accent when they acquire a second language, and it is often a great challenge for mature speakers to produce L2 segments with their phonetic details. Young children, on the other hand, who acquire an L2 prior to the age 5 or 6, produce the L2 sounds with correct phonetic details (and they produce the L2 either with no L1 accent, or very small traces of an accent). Best explains that young children are able to recognize the articulatory gestures of the speech regardless of what the L2 is, and she further suggests that there must be "at least some time during the developmental process of language learning, that auditory

system must be capable of physiological sensory registration of the acoustic results of the phonetic gestures employed by natural languages" (Best, 1992:171).

2.2. The perception and production of L2 sounds

2.2.1 PAM

As, demonstrated, it is generally accepted that non-native segments are perceived according to their similarities to and discrepancies from native sounds. Best (1995) has proposed the Perceptual Assimilation Model (PAM), according to which similarity between non-native and native segments determines a listener's "perceptual assimilation of non-native segments to native categories" (Best, 1995:193) Best in (1995) explains that languages differ phonologically in the selection of simple gestures in their native phonological spaces. Therefore, while some gestures are used to produce phonemes in one language, in a second one they could only function as allophones in a particular environment. As the author of the model points out, non-native sounds are those whose gestures do not match precisely with L1 constellations (Best, 1995:193). PAM's main tenant is that L2 sounds are perceived on the basis of the similarities and discrepancies from the constellations in the native phonetic or phonological system. If L2 and L1 sounds are similar, then they are likely to be assimilated to the sound in the native phoneme inventory. On the other hand, if there are discrepancies in constellations between L1 and L2 sounds, the language learners are expected to be able to detect that, especially in case of large differences. Moreover, while some of the non-native sounds could be perceived as speech-like but not from the L1 sound inventory, some could be even as non-speech gestures, for example "chocking", "fingers snapping" or "cork popping" (Best,1995:194).

Therefore, Best (1995) has suggested three patterns of assimilation of non-native segments which will be presented in Table 1.

Three patterns of assimilation of L2 sounds to L1 perceptual categories:
a) Assimilated to an L1 category, in this case an L2 sound could be heard either as: - A good example of the L1 category - An acceptable but not ideal example of the category - A notably deviant example of the category
b) Assimilated as un-categorical speech sound
c) Not assimilated to speech (non-speech sound)

Table 1. 3 patterns of assimilation of L2 sounds to LI perceptual categories (adapted from Best, 1995, p. 194).

Best also predicts the different degrees how L2 language speakers perceive non-native contrasts with the regards on the assimilation of each segment in their L1. If both of the L2 sounds are assimilated to different L1 correspondents, then the discrimination of this L2 contrast is predicted to be "excellent" (Best, 1995:195). The other scenario for the perception of non-native contrast is when both L2 sounds are assimilated to the same L1 category (referred to by Best as *Two-Category Assimilation*). However, there could be two different cases of this, either when one segment is "acceptable" and the other one is "deviant" from an L1 sound (*Category-Goodness Difference*) (Best, 1995:195) or when both L2 categories equally vary from the L1 segment (*Single-Category Assimilation*) (Best, 1995:195). In the first situation, discrimination should be from moderate to very good depending on the scale of perceived difference between L2 segments and in the second situation the discrimination is expected to be poor or even impossible. On the other hand, if both L2 sounds are perceived as speech-like but are not close to any particular L1 segment in phonetic space (*Both Uncategorizable*) (Best, 1995:195), then those sounds are uncategorizable and the discrimination between them is predicted to differ from poor to even very good depending on their proximity to each other and to L1 segments in the native phonological inventory. If only one sound from the L2 contrast is assimilated to a L1 segment and the other is not (*Uncategorized versus Categorized*), then according to PAM discrimination between those non-native categories should be very good (Best, 1995:195). All of the five contrast assimilation patterns described above regard the non-native segments that are perceived as speech-like, however Best also includes a sixth assimilation pattern for L2 segments that are not so (*Nonassimlabl*e) (Best, 1995:195). If both L2 categories are not heard as speech sounds, and if they vary, than the discrimination is predicted to be "good" or "very good" (Best, 1995:195). PAM's six assimilation patterns are summarized in Table 2.

Assimilation and discrimination of L2 contrasts:
1) Two-Category Assimilation -Each L2 sound is assimilated to a different L1 category. -Excellent discrimination
2) Category-Goodness difference -Both non-native segments are assimilated to the same L1 category but they vary from the L1 "ideal", i.e. one is acceptable and the other one is "deviant". -Moderate - very good discrimination
3)Single-Category Assimilation -Both non-native sounds are assimilated to the same L1 category and they equally discrepant from the native segment (or equally accepted) -Poor discrimination
4) Both uncategorizable -Both segments are heard as speech sounds but none of them is assimilated to L1 segments -Poor - very good discrimination
5) Uncategorized vs. categorized -Only one L2 sound is assimilated to an L1 category and the other is not -Very good discrimination
6) Nonassimilable -Both L2 sounds are heard as non-speech -Good - very good discrimination

Table 2. Assimilation and discrimination of L2 contrasts (adapted from Best, 1995, p. 195)

In conclusion, some L2 sounds may match the categories of L1, while others may appear speech-like but do not match any sounds of the native inventory, and in extreme cases, some sounds can even be identified as non-speech sounds. The discrimination between non-native contrasts is dependent on the perception of their individual sounds.

2.2.2. SLM

The Speech Learning Model (SLM) is another model developed to account for non-native speech perception for experienced L2 users and takes into considerations limits for productions of L2 vowels and consonants in a native-like fashion (Flege, 1995: 237). As Flege explains, the phonetic system is adaptive over the life span and when encountering new L2 sounds, it adds new or modifies the old phonetic categories present in L1 (Flege, 1995: 233). SLM is a reaction against the Critical

Period Hypothesis (Lenneberg, 1967) which states that age is crucial for a language acquisition. According to Lenneberg acquisition of language is innate and it is determined by biological factors, and after lateralization (which is at puberty) the optimal language acquisition is very difficult or even impossible (Lenneberg 1967, cited in Collier, 1987/1988).While Flege does not deny this theory in itself, he does question its absolute validity, providing empirical evidence from one of his studies (Flege, Munro & Mackey, 2003) which revealed that there is no critical period in regards to the degree of perceived L2 foreign accents of the participants and therefore to the ability to attain the perception and production of L2. Moreover, based on his studies, Flege notes that even though foreign accents are frequent in a second language speech, it is possible for an adult learner to acquire native-like pronunciation in L2 (Flege,1995:236). Therefore, SLM rather promotes the Sensitive Period Hypothesis according to which the ability to learn a language does not decline dramatically after reaching a certain age but it rather happens more gradually (Gass & Selinker, 2008: 406). Flege also criticized previous views of second language acquisition noting that they rather only consider L1 interferences and ignore other important factors such as how long an L2 has been spoken or to whom, and age of learning.

One of the main SLM tenets is that an accurate production of L2 sound inventory does not depend on only "the learning of gestures with which to reliably produce the represented L2 sounds" (Flege, 1995:236) but also on the correct perception of those sounds. Flege explains that language learners tend to perceive L2 sounds on the basis of their L1 phonetic system, and therefore L2 phonetically distinct sounds might be assimilated with inappropriate phonetic categories of L1 (Flege, 1995:238). Therefore, according to this model, the production of L2 sounds will be not accurate if the speakers do not perceive them appropriately.

SLM provides seven hypotheses about the nature of the L2 sound production. According to the first hypothesis language learners perceive L2 allophones to the closest sounds in their L1 phonetic inventory (Flege, 1995:239). This prediction is supported by the empirical evidence from the studies revealing that bilinguals are more or less successful at perceiving and producing different L2 sounds. An example was mentioned earlier: Japanese speakers of English have a great difficulty in perceiving and producing the English liquids /ɹ/ and /l/ which are contrastive sounds in English and not in Japanese. Strange's (1992) work demonstrated that while those speakers tend to fail to perceive and produce those sounds appropriately at the beginning of the word, they do not fal at word-final position (cited in Flege, 1995:239). This could be due to the fact that the acoustic difference appears for them to be more obvious at the end of the word than at the beginning (Sheldon and Strange, 1982, cited in Flege, 1995:239).

According to the second hypothesis, language learners can establish a new phonetic category for L2 sounds which is different from the nearest one in their L1 if they are able to hear any differences between them (Flege, 1995:239). The third prediction is that the greater the difference between those sounds, the easier it is for bilinguals to detect it.

The fourth hypothesis predicts that together with the increasing age of arrival in the country where the L2 is spoken, the ability to learn to spot the differences between the L2 distinct phonetic sounds absent in the L1 decreases (Flege, 1995:239). According to the fifth prediction, L1 and L2 sounds that are perceptually linked (referred as "diaphones") become the same sound for the production of both languages (Flege, 1995:239). This has been supported by the study by Flege (1987a), which revealed that the L2 language learners produced stops in their L1 with the VOT values for stops in the L2 (cited in Flege, 1995).

The sixth hypothesis states that the L1 and L2 vowels of bilinguals tend to be dispersed, so that the auditory contrast between them can remain intact (Flege, 1995:239). Therefore, a new established category for an L2 sound will differ from the target one and from the existing before L1 sound. *Phonetic dissimilation* could be an example of such a phenomenon, which occurs when L1 and L2 phonetic systems interact and when a category for a new L2 sound has been established (Flege, MacKay, Schiru, 2003:470). According to the authors, a newly established non-native category and its closest L1 segment move away from one another and phonetic dissimilation happens when bilinguals try to maintain phonetic differences between all of the L1 and L2 sounds, however their productions vary from the native-like. Moreover, according to SLM, bilinguals attempt to maintain the phonetic contrast between all of the categories in their common phonological space for both languages in the same way as monolinguals do. This assumption was confirmed by the Flege MacKay and Schiru study, which tested the perception and production of English vowel /eˈ/ by Italian-English bilinguals (2003). The results revealed that those participants who arrived to the L2 country between ages 2 and 13 and indicating a low use of L1 produced the target vowel with more tongue movement than those who arrived between the ages of 15 and 26 and indicating a high use of L1. The latter group, on the other hand, articulated the tested sound /eˈ/ with less movement than the NE speakers did since they treated this L2 vowel as an instance of its counterpart in the native system (*phonetic category assimilation*).

Bohn & Flege (1992) have also tested the effect of the L2 experience on the production of L2 and the effect on the sound correspondences between the native and non-native languages. The authors argue that mature L2 speakers can articulate non-native segments authentically if there is a

big enough difference between that sound and an L1 sound, and if the learners have been exposed to the target language sufficiently (Bohn & Flege, 1992: 132). They support their claim with evidence from previous studies which revealed that experienced English speakers of French pronounced the new French vowel /y/ appropriately, while /u/, which is present in both languages, was produced in an English-like way (Flege, 1987 cited in Bohn & Flege, 1992:132). The authors also argue that not only L2 experience but also sound correspondences between the native and non-native language has a great impact on L2 production. As noted above, speakers of English were able to establish a phonetic category for a new sound /y/, while they dragged the French /u/ to the same sound in their L1 and treated them as equivalent (which is referred to as *equivalence classification*) (Bohn & Flege, 1992:132).

Finally, according to the seventh prediction, if bilinguals establish a new phonetic category for an L2 sound which will also match the native speakers', then their production of that sound will be appropriate (Flege, 1995:239).

In summary, an L2 speaker will change the way he/she produces the phone if a new category is established for it, but the production of an L2 vowel may also change if a new category is not established. This happens when an L2 phonetic category is linked perceptually to an L1 correspondent, referred to as a "diaphone", a phonological unit that identifies a correspondence between related sounds. Both developments tend to lead to a more native-like production of L2 sounds; however the first one should result in more rapid changes in L2 productions. According to SLM, new L2 sounds are presumed to be easier to perceive in an accurate native-like way than L2 sounds which are similar to L1 sounds that may be merged into one category. However, with some experience, the L2 language speaker may learn to perceive non-phonemic features different from its L1, which will help to establish a new category similar to the L2 sound category.

There are different types of bilingualism distinguished respectively by different criteria (see Hamers & Blanc, 2000); however for the purposes of this work it is important to distinguish sequential bilinguals from simultaneous bilinguals. Speech perception and production studies show different performance rates within these types. Sequential bilinguals acquire their L2 after their L1, which is the population targeted in this study. They acquire L2 phonology after the perception patterns of L1 are already established. Simultaneous bilinguals acquire two languages, including two phonological systems, at the same time from birth.

Moreover, there has been a significant interest devoted to acoustic cues (Repp, 1984) which signal phonological distinctions of the contrasting sounds and which will be discussed in Section 2.3.2.

2.2.3 PAML2

Best & Tyler (2007) note that while PAM was developed to describe non-native speech perception by inexperienced learners and SLM (Flege, 1995) was developed to explain the production and perception of L2 speech by experienced listeners, neither was intended for both situations, and the authors probed "commonalities and complementarities of these two models" (Best & Tyler 2007:14) in order to explore if SLM could be applied to extend PAM's framework of non-native speech perception (Best & Tyler, 2007:22). The inexperienced listeners are referred to by the authors as naïve perceivers who do not know which phonetic distinctions create different phonemes in the new target language and cannot differentiate the phonetic and phonological levels in non-native speech. Therefore, the phonetic and phonological levels are for these listeners linked only to L1, in which the phonetic levels were established for the contrastive phonemes together with the early lexical and grammatical development stimuli (Best & Tyler, 2007: 23). The authors argue that phonological levels are central for SL listeners who are learning L2, in a way that cannot be for L2 naïve learners.

In order to extend PAM, Best & Tyler examined and compared both models and looked for the divergences and convergences according to four following SLM postulates. According to the first postulate the different mechanisms and processes which were used during L1 sound acquisition such as when forming sound categories do not change over the life span and can be applied to L2 sound development as well (Best & Taylor, 2007:24). While both PAM and SLM agree that adults have perceptual learning abilities to acquire an L2 sound as children for their L1, PAM postulates that the L2 learning is of a different nature, since it is rather an extension of already acquired sounds. Moreover, contrary to SLM assumptions, this does not happen by formation of new categories from the phonetic cues but from the extracting invariants for acoustic constellations from speech (Best & Taylor, 2007: 25).

The second postulate is "the language-specific aspects of the speech sounds are specified in long-term memory representations called phonetic categories" (Best & Taylor, 2007:25). PAM rejects this assumption, since in this view, the listener attunes to the invariants from the speech sounds rather than establishing new categories for them. Moreover, according to the new Best and Taylor's model PAM-L2, the perception is dependent on the listener's goals and focus of attention.

As the authors contend, in some cases perceivers will have to discriminate speech sounds from non-speech, or in other cases their focus could be on the phonological or phonetic level. The term *phonological category* is used by Best & Taylor (2007:25) for speech information that refers to minimal lexical differences in a particular language while *phonetic category,* on the other hand, refers to "invariant gestural relationships that are sub-lexical yet still systematic" (Best & Taylor, 2007:25). The authors further explain that phonetic categories are heard by attuned listeners such as "positional allophones or differing realizations of a phonological category across dialects or languages," and they do not contribute to changing the meaning of words; however they may provide information about, for example, a speaker's identity, region or mother tongue.

The third postulate states that phonetic categories for L1 sounds change during a lifetime, so they can reflect L1 and L2 phones as a realization of each category (Best & Taylor, 2007:25). According to PAM, as discussed in postulate 1, listeners change their perception of the speech gestures over the lifespan, and as the authors explain, it takes the learner to "discover a different set of invariants to encompass the new shared phonological category" for L2 sounds that are dragged to an L1 nearest phonological correspondent. (Best & Taylor, 2007:25-26). Best & Taylor also depict how the non-native L2 phones are identified as equivalent to L1 sounds. While SLM posits that it involves "passive reception of meaningless proximal stimulus details (acoustic features) and computation of their statistical distribution in the input", PAM argues that the listeners actively look for "intrinsically meaningful distal event information", which "refers to vocal tract gestures and their coordination". Therefore, Best & Taylor posit "that L1 and L2 phones are identified as realizations of the same inter-language phonological category when they are recognized (correctly or incorrectly) as involving functionally the same gestural constellation, for which the parametric details (gestural phasing, constriction location and degree) may or may not differ in a phonetically gradient, rather than phonologically functional, way" (Best & Taylor, 2007: 26). As they continue, "contrasts at the functional linguistic level of L1 phonology and their relationship to phonological contrasts in the L2 are as important to perceptual learning as phonetic categories in the two languages according to PAM but not SLM" (Best & Taylor, 2007:26). Moreover, "such phonological assimilation need not imply that the associated phones are perceived as identical at the phonetic level" (Best & Taylor, 2007: 26) such as illustrated example of /r/ in English vs. French.

The fourth postulate is that "bilinguals strive to maintain contrast between L1 and L2 phonetic categories, which exist in a common phonological space" (Best & Taylor, 2007:27) Best & Tyler's revised PAM-L2 model agrees with this assumption, however it must be noted that according to PAM "both phonetic and phonological levels interact in L2 speech learning". Therefore, when an

L2 phonological category is assimilated to one L1 phoneme and its phonetic versions can be differentiated, then according to the authors L1 and L2 phones should be maintained as separate realizations of the one phonological category (Best & Taylor, 2007:26).

Moreover, Best & Tyler's PAM-L2 (2007) predicts four possible cases of L2 minimal contrasts. In the first situation, only one phonological category is assimilated or is perceptually equal to L1. there is one segment of L2 contrast that is heard as matching to a particular L1 sound, then as the authors explain, there does not need to be any further learning (p. 28). However, if both L2 members are assimilated to one separate L1 categories or only one is assimilated to the L1 category and the other is not, then the listener should not have great difficulty differentiating between the members of the contrast. As already discussed, the listeners tune their perception according to functional sounds over the lifespan and the phonetic categories for L1 should shift due to the new bilingual environment (Best & Tyler, 2007:28).

In the second situation, both categories are associated with the L1 nearest correspondent; however one of them is more "deviant" than the other (Best & Tyler, 2007:29). PAM refers to such phenomena as a category goodness assimilation contrast, in which listeners should be able to distinguish both members of the contrast well, but not as well as in two category assimilation (both L2 categories are perceived as two separate L1 sounds). Best and Tyler further explain in this kind of assimilation learners should be able to differentiate the sound in the minimal lexical contrast fairly easily and language learners are expected to establish new phonological and phonetic categories for the "deviant" segment of the contrast rather than for a better corresponding to L1 segment since it would be treated as an equal phone in a native language and therefore none new categories would be formed

The third assimilation type is when "both L2 phonological categories are perceived as equivalent to the same L1 phonological category, but as equally good or poor instances of that category" (Best & Tyler, 2007:29). In this kind of situation, a listener will find it difficult to discriminate between L2 phonological categories that are instances of one L1 category and such a minimal pair would be heard as homophones. According to SLM, both non-native sounds would be assimilated to one native category. Best & Tyler contend that the success of learning how to discriminate those sounds depends on whether they are good or poor instances of L1 phonological category. Moreover, they claim that a listener could attune to such an L2 contrast; however, first they would have learned how to perceive at least one L2 phone to be able to create a new phonological category (categories).

The fourth situation would be if there is "no L1-L2 phonological assimilation" (Best & Tyler, 2007:30) and PAM would refer to such phenomena as Uncategorized Assimilation. None of the L2 phones are perceived as L1 correspondents and according to Best and Tyler, both members of the contrast should be learned by the subjects without any difficulty. According to SLM, such a situation could be an example of new phones, however as the authors argue, in the PAM framework it is not similarity or dissimilarity that underlies the L2 perception but the relationship with the interlanguage phonological system. In such a situation if both non-native phones have similarities to different sets of L1 categories, then perceivers should easily detect the L2 lexical-functional differences in the minimal contrast and both categories should be learned to be perceived appropriately. However, if both of the L2 categories have similarities to the same L1 phone, then it will be difficult for a learner to recognize sound differences in the lexical-minimal pair of that contrast, therefore they would remain homophonous. As the authors explain, a new single phonological category could be learned for both L2 phones, however over the course of L2 acquisition the language learners could establish separate categories for that sound.

2.3.1. LP

Escudero (2005) introduces the most elaborated L2 perception model so far, the Second Language Linguistic Perception Model (L2LP) which depicts the process of acquiring L2 phonetics and phonology. L2LP applies to both non-experienced and experienced L2 listeners. Also unlike PAM and SLM, L2LP is based on a phonological analysis, not on the phonetics as in the other two models. The L2LP is developed on the concepts for L1 perception and Escudero argues that these can be extended to L2 perception as well.

To begin with, Escudero cites Brown (1998), Hyman (2001) and Hume & Johnson (2001b) "in that the speech signal is first handled by universal phonetics and then by a phonological component" (Escudero, 2005:12). She illustrates that speech perception consists of a two-step mapping and that it is crucial to distinguish between phonetics and phonology since they occur at two different levels of representation (Escudero, 2005:43). As Escudero summarizes, the acoustic signal is divided into L1 phoneme categories in a first order through the listener's phonological structure. One of the Universal Phonetics assumptions is that a language decoding of the speech signal into discrete categories is performed by a *perception grammar*, which "performs the mapping of the speech signal through constraints that map or connect the acoustic properties of the input with sound representations" (Escudero, 2005:44). Those constraints are referred to in the literature as *cue constraints* and they map the signal onto phonological categories which described the perception grammar of adults, and integrate multiple auditory dimensions in phonological sound perception

(Escudero, 2005:49). Escudero and Boersma (2003) note that when adults perceive different meaningful speech units such as vowel or consonants, they cumulate different cues (cited in Escudero, 2005:47). This could be illustrated by the example of English speakers whose perception grammar integrates both spectral and durational dimensions to categorize the vowels /i/ and /ɪ/ by relating both to the same phonological segments (Escudero, 2005:48).

According to Boersma's Linguistic Perception Model (1998), different characteristics, such as for example a phoneme inventory in the ambient language, underlie the way the speech is mapped perceptually by a subject. Boersma's model accounts for L1 speech perception and it assumes that the knowledge of a language underlies the way in which the stimulus is mapped since it is language-specific (cited in Escudero, 2005). One of the LP's postulates is that perception consists of three elements: (1) an auditory signal which is decoded by (2) perception grammar, and the outcome of perceptual mapping which are (3) perceptual representations (Escudero, 2005: 43). Those, on the other hand, are decoded by *recognition grammar* as existing words in the lexicon. (Escudero, 2005:43). Phonological representations, however, are "discrete and arbitrary symbols" that represent the sounds of language (Escudero, 2005: 43). Escudero (2005) explains that the L1 acquisition of speech perception consists of the listener's formation of the abstract sound representations that are specific to a particular language by the means of creating adequate perceptual mappings (44).

2.3.2. L2LP

To begin with, it must be noted that L2 listeners' auditory information recognizes sound categories differently than native speakers of the target language. In her work, Escudero (2005) illustrates that even though some languages may share some phonological categories; their perceptual mappings are probably different and have different boundaries (87). Therefore, based on that, L2LP predicts two learning tasks when reaching L2 optimal perception: perceptual and representational tasks, which will be described later in this section. As discussed previously, the perception grammar determines the sound perception since it has cue constraints that analyse the speech input and classify the constraints to their adequate phonemes (Escudero, 2005:90). Three different results are proposed for an optimal perception grammar: "location of category boundaries", "the shape of category boundaries", and "the relative use of auditory dimensions" (Escudero, 2005:90).

L2LP is formed from theoretical sequential ingredients which aim to predict, explain and describe L2 sound perception at the initial, learning and end state of L2 phonology acquisition (Escudero, 2005:95). Ingredient 1 is the description of the optimal perception (the language

particular perceptual mappings and their phonological representations) in both L1 and L2 which directly relates to the next ingredient.

Ingredient 2 is referred to by Escudero as the initial state (Escudero, 2005:97). In L2LP this state is identified with no prior listener's experience of the target L2. According to the L2LP, both L1 and L2 acquisition have an initial state which is different from the optimal perception and which is a development of the perceptual system. During that state both in L1 and L2 acquisition, the perceptual system is dynamic and not the same as the optimal perception of the particular language; however at the end state it stabilizes (Escudero, 2005:95). The learner at this stage copies L1 perceptual mappings and as a result the L2 sounds are perceived according to the L1 phonological categories. Such is illustrated with the example of L1 Spanish speakers and their initial perception of the English vowels /i/ and /ɪ/. Learners will apply their L1 perceptual constraints, which will results in categorization of the both L2 vowels into a single unit /i/. Such mappings are referred to as *already-categorized dimensions* (Escudero, 2005:102), however Escudero notes that are also *non-previously categorized dimensions* (Escudero, 2005:102). The latter is illustrated again with an example of Spanish listeners who "do not have any constraints that map vowel duration to length categories" (Escudero, 2005:102).

Ingredient 3 is the learning task, which refers to what learners must develop to reach the optimal L2 perception (Escudero, 2005:105). This can be predicted from the differences between the optimal phonologies of the languages of interest. According to L2LP, the learning task will be the same as are the differences between the optimal perceptions, and can be predicted on the basis of them. According to the model's postulates, the L2 learner "should change [her] L2 initial perception in order to match the optimal L2 perception" (Escudero, 2005: 107) and she will have to face either both perceptual and representational tasks, or in some cases just the former one. The author of the model predicts that if there are no representational differences between L1 and L2 then the learner will face only the perceptual task (Escudero, 2005:107).

In order to reach an L2 perception, the initial perception grammar may have to be adjusted. If the target sounds are those "with already-categorized dimensions in one's L1 perception grammar" (Escudero, 2005:108), then the perceptual task will be to create new categories through redistribution or splitting of L1 perceptual mappings (Escudero, 2005:108). However, if those sounds are with non-previously categorized dimensions in a native language, then the learner will have to establish new mappings in order to appropriately perceive the new required distributions (Escudero, 2005:108).

The representational task, on the other hand, requires establishing a new phonological category. Escudero (2005:109) illustrates such a phenomenon with the example of Spanish learners of English, who are most likely to perceive the same sound in the minimal pair "sheep" and "ship", which results in having the same lexical representations for semantically distinct words. In that case, the L1 recognition grammar will perceive both as the same phonological form /ʃip/. Therefore, the learner will have to create another phoneme to differentiate the words and the difference between the vowels.

Moreover, Escudero distinguished three different learning scenarios in her model which are based on the differences between L1 and L2. The first one, the *new scenario* (Escudero, 2005:123) is when the learner perceives fewer categories than an L2 produces. L1 perception grammar contains fewer categories and therefore it could lead to two distinct phonemes to be perceived as one L1 sound. The representational task here is to recognize new sounds as distinct phonemes. The other is the *similar scenario* (Escudero, 2005:123), in which the listener perceives the same number of phonemes in both L1 and L2, even though they are phonetically different. And lastly the *subset scenario* (Escudero, 2005:123) is when the L2 categories are just a subset of L1. The perceptual task in this case is to adjust the different category boundaries and in a similar scenario no representational task is needed. According to L2LP, the new scenario is the most difficult of all three, since it requires a learner not only to create new categories and their perceptual mapping but also to integrate those new dimensions with already- categorized dimensions. The similar scenario, on the other hand, is the least difficult since both languages have equivalent L1 and L2 categories. Escudero (2005) summarizes these three learning scenarios as shown in Table 3.

	NEW	SUBSET	SIMILAR
Initial state	Too few categories	Too many categories	Non-optimal mappings
Perceptual task	Two tasks: Creation and integration	One task: Category boundary shift	One task: Category boundary shift
Representational task	Two tasks: Create features and turn them into segments	Two tasks: Reduce lexical and perceived categories	None
Relative difficulty	Most difficult	Medium difficulty	Less difficulty

Table 3. Predicted initial states and learning for the three L2LP scenarios (from Escudero, 2005).

Ingredient 4 is referred to by Escudero as L2 development in which the learner will have to realize the L2 learning tasks. Therefore, an L2 listener will have to acquire all L2 categories for an optimal L2 perception. Therefore, as discussed above, one will either generate new perceptual mappings for the new phonemes or adjust the existing ones (Escudero, 2005:109). According to L2LP postulates, L2 learners have an access to a learning device (referred as GLA) which allows the acquisition of L1 perception (Escudero, 2005:110). Thanks to this device, it is possible to eventually adjust L2 perception and according to the model's author, L2 learners are supposed to establish new categories or adjust their boundaries in the same way as infants do in their L1 perception. Therefore, as a result, L2 learners are predicted to create categories along dimensions that are not distinct for the L1 sound classification (Escudero, 2005:102). This was illustrated by Escudero with the example of L1 Spanish speakers of English who will gradually generate perceptual mappings that relate vowel duration values with the newly established vowel length categories – long and short, such as in the example given before of /i/ and /ɪ/ in words "sheep" and "ship".

Ingredient 5 is the L2 end state (Escudero, 2005:113) whereby in accordance with L2LP the L1 and L2 perception is optimal and the languages do not have an impact on their representations since there are separate perceptual systems for them (unlike Flege's assumption of a common space for phonology for both languages (1995)). According to L2LP, learners who use the both languages will develop their L2 perception, while L1 remains stable (Escudero, 2005:114-115).

All of the five Ingredients that consist on L2LP are summarized by Escudero in Table 4.

L2LP	PREDICTION	EXPLANATION	DESCRIPTION
Optimal L1 & target L2	Human beings are optimal listeners	Optimal listeners handle the environment maximally well	L1 and L2 optimal category boundaries: Location & shape
Initial state	=Cross-language perception	Full Copying	L1 boundary location and shape
Learning task	= Reach the optimal target L2 perception	L2	Bridging mismatches between L1 and target optimal perception
Development	= L1-like	Full GLA Access	Category formation and boundary shifts
End state	Optimal L1 perception and optimal L2 perception	Input overrules plasticity Separate grammars	Language activation modes, through language setting variables.

Table 4. A summary of the L2LP's theoretical ingredients (from Escudero, 2005).

2.4. The Polish vs. English vowel systems

Polish has 6 vowel phonemes (excluding nasalized vowels), as shown in figure 2. English, on the other hand, has a much more complex system, comprised of 12 vowels (excluding diphthongs), which is illustrated in figure 1. Vowels are classified with regards to tongue height and backness (its position in the oral cavity).

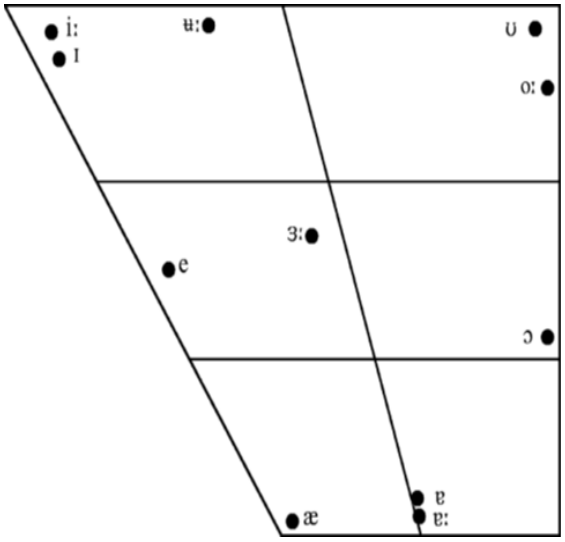


Figure 1. Australian English monophthongs (from Cox, F., & Palethorpe, S, 2007)

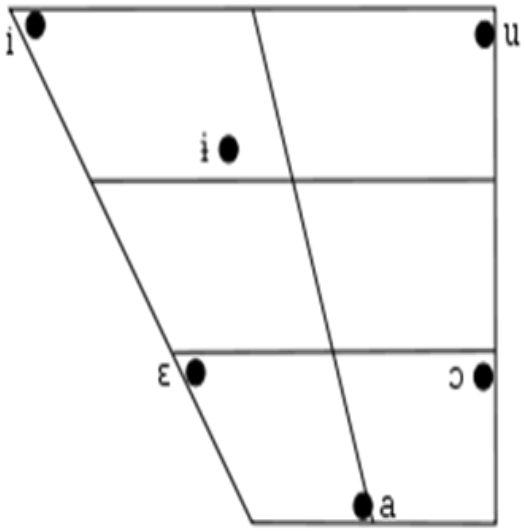


Figure 2. Polish monophtongs (from Jassem, 2003).

\The Polish vowels are phonemic, and there are minimal pairs to attest to this: b[ɨ]ty "entities", b[u]ty "shoes" (examples from Jassem, 2003). These seem to be obvious to Polish speakers since both of these phonemes exist in their native language and they all add or change a new meaning to the string of segments. However, as discussed before, phoneme inventories differ among languages and phonemes or contrasts between them that are absent in the L1, as we have seen, are generally difficult to learn to perceive or produce in L2 (Best, 1995; Flege, 1995). As depicted in Figures 1 and 2, the English vowel phoneme inventory is much richer than Polish (if the nasalized vowels are excluded).As result Polish learners of English are likely to face some difficulties with the perception and production of a number of English vowels.

For the purposes of this work, particular attention will be devoted to the differences between the Polish and Australian English vowel systems. In opposition to Australian English, the Polish vowel system does not contrast in length. AE has 6 vowels which are short: [ɪ], [e], [æ], [ɐ], [ɔ], [ʊ] in the words "bit", "bet", "bat", "but", "pot", "put", and 6 vowels which are long: [iː], [eː], [ɐː], [oː], [ʉː] [ɜː], such as for example "beat", "cared", "Bart", "bought", "boot", "Bert"(Cox, 2012:57). Therefore the phonemic distinction and short-long contrast is present in the following pairs: [ɪ] – [iː], [e] – [eː], [ɐ] - [ɐː], [ɔ] – [oː], [ʊ] - [ʉː] and [æ] -[ɜː]. Because Polish does not have a contrast in length, speakers may have difficulties in differentiating those non-native contrasts such as in the vowel pairs above. Cox (2012) concludes that short vowels are approximately 60% of the length of the long vowel and that diphthongs belong in the group of long vowels as well (Cox, 2012:57).

However, the vowels can also be categorized according to their position in phonetic space, and again due to Australian English being richer in the phonemic vowel inventory, the accurate perception or production for L1 Polish learners of AE sounds may be a great challenge. As depicted in figures 1 and 2, Polish has two high front vowels as English does; however while both languages share /i/, which in English is a long sound /i:/, they differ with the second one: AE /ɪ/ versus Polish /ɨ/, which is positioned much lower and further to the centrum of the chart than the other vowel. The third and last high Polish vowel is /u/, which is situated much higher than AE /ʊ/ and /o:/ and further back than /ʊ/. The most Polish high-central vowels is/ ɨ/ and Australia English possesses /ʉ:/.With the regards to mid vowels, from the figure 2 it must be observed that Polish does not include any of these sounds, while when looking in figure 1 we can see that AE has two mid-front vowels: /e/ and /e:/, one mid-central /ɜ:/ and one mid-back /ɔ/. Lastly, while Australian English has three low vowels positioned right at the bottom of the chart (low-front /æ/, and low-central /ɐ/ and /ɐ:/). As shown here, there are striking differences in vowel spectral distinctions between the two languages which are predicted to have a great impact on the perception and production of these L2 English sounds by Polish subjects.

While both length and spectral differences are essential for vowel identification, it has been demonstrated that spectral information plays a primary role in vowel perception for native English speakers, and length just secondary one (Hillenbrand, 2013:26). However, different patterns were recognized in non-native perception of English vowels by L1 Spanish and Russian speakers. Spanish and Russian speakers rely primarily or even in some cases exclusively on length when identifying sounds from a tense-lax contrast (Kondaurova & Francis, 2008:3969). Escudero and Boersma (2004) account for such phenomena by applying the L1 mechanism for acquiring optimal perception, which detects the duration differences which are absent in their L1 in contrast to the spectral ones .On the other hand, Bohn (1995) explains it with his desensitization hypothesis that duration distinction will be used in the vowel identification when spectral properties are difficult to perceive by a listener no matter what experience in duration in L1 is.

2.5. Previous research on perception/ production of English vowels by L1 Polish learners.

As suggested above, language users attune to the specific significant sounds that function in their system and any differences between L1 and L2 can be problematic to achieve in a native-like manner. There is a tendency for English vowels to be replaced by the nearest Polish vowels when the languages are in contact. Based on observations during teaching, Puppel (1990:247) has proposed two kinds of English vowel substitutions by Polish L1 users. The first one is English-Polish, where an English target vowel is substituted with the nearest Polish vowel; this phenomenon occurs more

frequently at the beginning of the foreign language learning process. The second one is English-English substitution, where an English target vowel is replaced with a different English vowel. This kind of replacement is not as frequent as the former and it is present slightly later in the learning process, since the learner needs to acquire at least some English vowel parameters first.

More research is required to explore Polish-speaking English learners' perception and production of English vowels and the tense-lax contrast in detail; however there have been studies that examined those aspects to some degree. Rojczyk's study (2010) reveals that two different English vowels, /æ/ and /ʌ/ (HCE transcription /ɐ/), are assimilated to one native category /a/ by Polish speakers, which can be predicted by PAM as a single category assimilation and by SLM as assimilation of similar categories. However, the author also notes that while the subjects may not rely on spectral values of those values, they may do so on durational values as earlier discussed by Escudero. Also, Kopeckova (2010) compared perception of the two vowel contrasts /i:/- /ɪ/ and /u:/ – /ʌ/ and the production of the phonemes between the native speaker of English in Ireland, the Polish immigrants living in that country, and finally Polish people in Poland. The study revealed that while all Polish participants (both adults and children) had difficulties discriminating /i:/- /ɪ/, the Polish children living in Poland discriminated /u:/ – /ʌ/ (in Cox's transcription /ɐ/). However, for the purposes of this study, it must be noted that Irish /ʌ/ is different from British and Australian /ʌ/ and it is much further back. Kopeckova (2010) also notes that in discrimination tests, Polish adults living in Ireland did not differ from the Polish children in Ireland in either of the tested contrasts; however the children produced a vowel /ʌ/ which was considered as accurate, and adults did not..Overall, in the production test the participants who live in Ireland performed better than those who live in Poland (Kopeckova, 2010), which confirms Flege's notion of the significance of language experience in the target country for the acquisition of L2 vowels.

Moreover, Bryla-Czuz (2010) examined the reactions to the Polish English pronunciation by native English speakers and her study revealed that the most foreign aspects of Polish accent are incorrect word-stress placement and mispronunciations caused by spelling interferences between the two languages which contributes to the disarticulation of the target vowels and difficulties in producing the tense-lax distinction. Therefore, Polish speakers may face difficulties in distinguishing between, for example, "live" and "leave" since they are very likely to recognize a phoneme [ɪ] in the first word as their native [i] which has the same orthographic representation.

3. The Study

3.1. Methodology

The aim of my research was to determine whether phonetic cues aid in the perception of non-native contrasts (and not only phonological ones; i.e. /ɪ/ - /i:/ are distinguished by only one phonological feature, [+tense], but two phonetic features, tenseness and length). For the purposes of this study, three contrasts of various phonetic differences were tested (HCE transcription): /ɐ/ - /ɐː/ (1 difference in length), /ɪ/ -/i:/ (2 differences: 1 difference in tenseness and 1 in length), /ɔ/ - /oː/ (3 differences: 1 difference in tenseness, 1 in length, and 1 in height/backness). Initially, the study was directed to Polish people, however later a group of Italian and Spanish speakers were added in order to examine whether the members of those three language groups have the same or different strategies for the perception of those absent in the L1 lax-tense contrasts.

Therefore, there were four main research questions:

1) Are different phonetic cues cumulated in the perception of non-native lax-tense contrasts by Polish, Italian and Spanish speakers of English?
2) Do Polish, Italian and Spanish participants rely more on spectral properties of a vowel present in their L1 when perceiving English /ɐ/ - /ɐː/ and/ɪ/ -/i:/ or durational properties absent in their L1?
3) What are the strategies for L2 perception by L2 speakers and how do they differ from L1 speakers?
4) Do the participants of the three language groups use the same or different strategies for discrimination between the members of L2 lax-tense contrast absent in their L1?

Mixed research methods were used in this project. The language background was explored by the interviews based on the questionnaire (qualitative method) and later the L2 vowel perception was analysed by a quantitative approach. All the scores for each group were calculated into percentages to establish a representation for each vowel contrast represented in each language group.

The study aimed to determine what kinds of cues are being exploited by non-native speakers when there are multiple cues available for a contrast in L2 and which cues are not available in L1 (such as tenseness and duration). A prime example of this scenario is provided by Polish, Italian or Spanish learners of Australian English. Australian English has a tense-lax distinction in vowels which is signalled by phonetic cues of length and vowel quality. Polish, Italian and Spanish lack contrasts based on either length or quality (Jassem, 2003; Rogers, 2004; Salcedo, 2010). This raises the question of which cues Polish, Italian and Spanish learners will rely on. The study also examined

to what extent length of residence and level of education helps in mastering a contrast between short and tense vowels in English by L1 Polish, Italian and Spanish speakers in the L2 environment of Australian English.

Due to the smaller native vowel systems and lack of a length contrast, the informants were expected to face difficulties in having an accurate perception and production of these English sounds. According to one of the PAM premises, the participants may assimilate the English vowels to their L1 correspondents if a new category for the non-native sound has not been established. It must be noted that according to both PAM and SLM there exists a common phonological space for both L1 and L2 sounds. The other possibility, based on L2LP, is that the learners developed appropriate perceptual mappings for the L2 phonemes, establishing a new L2 system while maintaining the L1 system.

This project examined the effect of length of residence and education on the non-native vowel perception; it did not explore other social factors and L1 use, which may play a significant role for these phenomena.

3.2. The participants

Fifty subjects with L2 English, ranging in age from 18 to 60 took part in the study. According to their L1 they were divided into three groups:

1) Polish
2) Italian
3) Spanish

Then, according to the participants' length of residence they were divided into five groups:

a) Less than one year

b) 1 to 2 years

c) 2 to 4 years

d) 4 to 8 years

e) 10 years and onwards

In total, there were 15 different groups according to time of residence (5 Polish, 5 Spanish and 5 Italian).

Then according to the level of education those groups further were divided into two subgroups: with the higher (University) and secondary (High-School).

Moreover, there was also a control group which consisted of the native AusEnglish speakers to ensure that the test was valid.

The distribution of the participants into groups of different time of residence and then level of education is presented in table 5.

Polish					
Time of residence (number of participants)	<1 year (4)	1-2 years (2)	2-4 years (5)	4-8 years (2)	+10 years (5)
Higher degree	2	2	3	2	3
Secondary degree	2	0	2	0	2
Italian					
Time of residence (number of participants)	<1 year (6)	1-2 years (4)	2-4 years (2)	4-8 years (1)	+10 years (4)
Higher degree	1	2	0	0	2
Secondary degree	5	2	2	1	2
Spanish					
Time of residence (number of participants)	<1 year (5)	1-2 years (4)	2-4 years (2)	4-8 years (3)	+10 years (1)
Higher degree	3	3	1	2	0
Secondary degree	2	1	1	1	1

Table 5. The distribution for the participants between the language group, time of residence and level of education.

3.3. The Test

The test was composed of 64 questions and consisted of three different parts.

In the first question the participants were asked what their L1 is, their length of residence in Australia and about their age.

3.3.1. Part I (question 2-23).

In the first test, the participants were presented with different minimal pairs produced from native Australian English speakers, such as [bit] “beat” vs. [bɪt] “bit”, [bɐ:t] “Bart” vs. [bɐt] “but”,

[koːt] “caught” vs. [kɔt] “cot” and were asked whether these were the “same” or “different” words. This test was composed of 21 questions, however only 9 included minimal pairs varying only in one of the research vowels. Thus, there were 3 questions testing the discrimination ability between the sounds from each vowel contrast (/ɐ/ - /ɐː/, /ɪ/ - /iː/ and /ɔ/ - /oː/).

Part I had three levels of difficulty. The first level involved recorded natural utterances. In the second level, however, the items were modified and their vowels “masked” by adding an extra noise to the recordings using Praat. Similarly a third level was developed, in which even more noise was added to the utterances to make the discrimination even more difficult. The second and third level of difficulty was generated in order to provide the stimuli that were challenging to discriminate by non-native speakers (level 2) and even by native speakers of AusEnglish (level 3).

3.3.2. Part II (question 23-46).

The second perception test involved participants listening to an utterance and matching its vowel to picture/pictures whose sound representation contained the same vowel. The images were used instead of the written words in order to limit the influence of orthography. This part of the test aimed at examining whether the participants had established in their lexicon the appropriate representational categories for the contrasting sounds

Part II was composed of 24 questions and there were four different types of questions. In all of the questions, the participants were played an utterance with a particular target vowel and they were always presented with three different images. In the first type of question, the participants were presented images of which each sound representation included a different vowel. Only one image’s sound representation included a vowel heard earlier in an utterance (same as in other types of question). In the second type, however, the participants were given pictures of which two included the members of the same lax-tense contrast. For example, in question 23 a word [liːv] “leave” was played and the informants had to choose from the images of /fiːt/ “feet”, /fɪŋgə/ “finger” or /hɛə/ “hair”. Figure 3 and 4 display the first and second type of question.

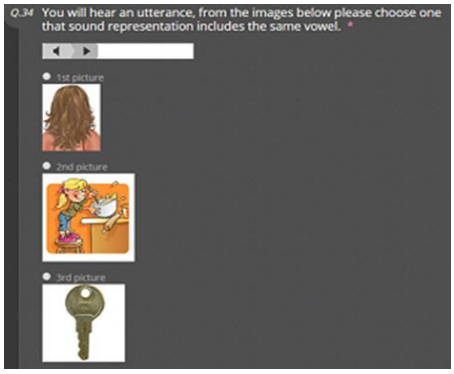


Figure 3. The first type of question (tested vowel /i:/,1st image: /fi:t/ "feet", 2nd image: / kʊk/ "cook", 3rd image: /ki/ " key")

Figure 4. The second type of question (tested vowel /i:/, 1st image: /hɛə/ "hair",2nd image: /fɪŋgə/ "finger", 3rd image: /hɛə/ "hair")

In the third type, on the other hand, the participants were given images whose sound representations all included members of the same lax-tense contrast. Such as for example, in question 40, the participants were played a word [fi:d] "feed" and they had to choose between the images of /pɪg/ "pig", /bi:/ "bee", /mɪrə/ "mirror". The fourth type of question was very similar to the third type; however this time there were two pictures with the tested sound (therefore 2 correct answers). Such as in question 30, the participants were played a word [fi:t] "feet" and they were provided with images of /tri:/ "tree", /bɪn/ "bin" and /tʃiz/ "cheese". The third and fourth type of question are presented in figure 5 and 6.

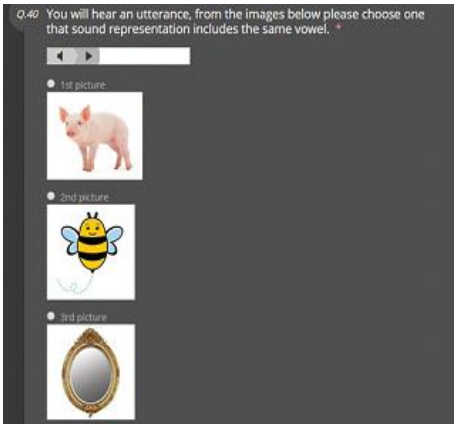


Figure 5. The third type of question (tested vowel /i:/,1st image:/pɪg/ "pig", 2nd image: /bi:/ "bee", 3rd image: /mɪrə/ "mirror")

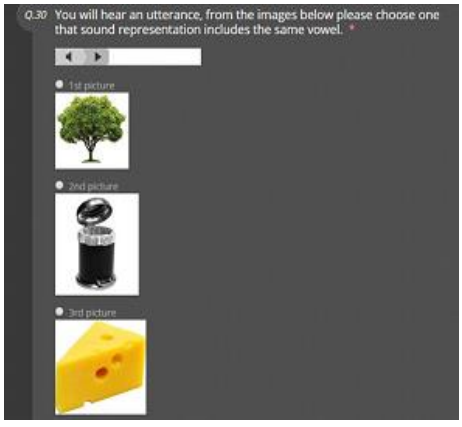


Figure 6. The fourth type of question (tested vowel /i:/, 1st image: /tri:/ "tree", 2nd image: /bɪn/ "bin", 3rd image: /tʃi:z/ "cheese")

It must be noted that the participants were told that all questions in Part II have at least one correct answer. All the questions always had the same available options to choose the answer from in order to limit guessing whether there were one or more images which sound representation had the target sound. These were the following options to answer:

a) 1st picture,
b) 2nd picture,
c) 3rd picture,
d) 1st and 2nd picture,
e) 1st and 3rd picture
f) 2nd and 3rd picture
g) All.

3.3.3. Part III (question 47-64).

Part III involved the participants listening to word and to match it with its orthographic representation .The informants were played a non-sense and ungrammatical sentence (so the correct answers cannot be guessed) and were presented with the written form of that sentence; however the word including the target vowel was elided with a blank such as depicted in figure 7.

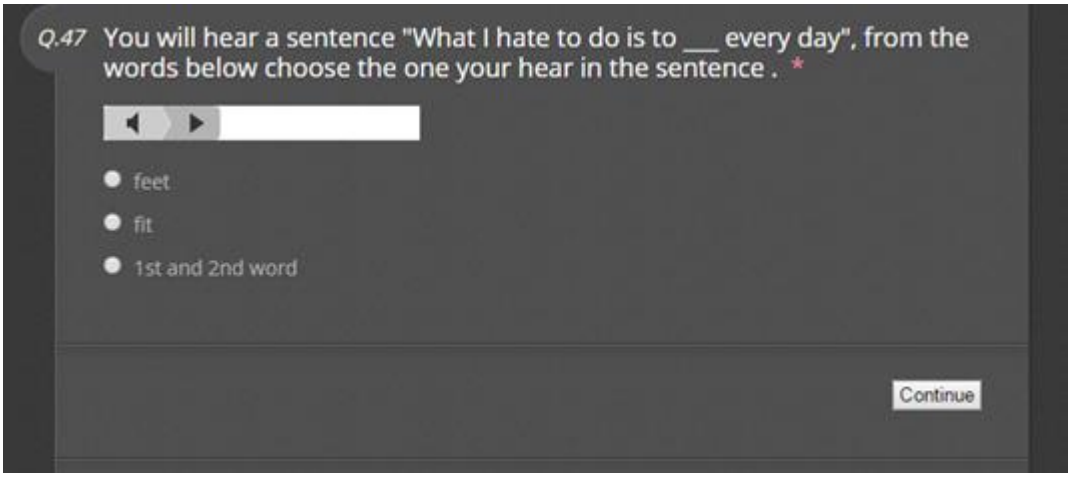


Figure 7. An example of question in Part III.

3.4. The Analysis

3.4.1. Part I.

Only the questions which included the utterances that were different words were taken into account in the analysis. The scores for each level of every contrast in Part I were added and then averaged.

3.4.2. Part II

It must be noted that first type of question was included in the study in order to make sure if the participants were paying attention. Every participant was able to answer this type of question correctly and if they did not, they were eliminated from the study. In total, there were 50 informants whose responses were accepted into the analysis.

For every contrast in the second, third and fourth type of question, the scores for the members of a particular contrast were averaged; for instance, the score for /i:/ was added to a score for /ɪ/ and then divided by two. This gave a score for the discrimination between the members of the tested lax-tense contrast.

Lastly, the average scores for each contrast in the second, third and fourth type of question were expressed as an average. This gave an overall score for the discrimination ability of each tested contrast in Part II.

3.4.3. Part III.

The scores for each vowel from the tested particular contrasts were averaged. Lastly those results of each tested contrast from the second, third and fourth type of question were added and then averaged to obtain an overall score for the discrimination between the lax and tense sounds.

3.4.4. The overall score for each contrast

Lastly, the overall score for each contrast from the three tests were averaged in order to investigate which contrast was generally perceived the most appropriately, which medium and which the least. Those results are described in section 4.4.

3.4.5. The analysis by time of residence.

a) Part I:

The overall scores of every contrast in each level were grouped by the time of residence, then averaged to examine whether length of residence had an effect on the discrimination ability in Part I.

b) Part II:

The overall scores of each contrast in every type of question were grouped by the time of residence, then averaged to examine whether length of residence had an effect on the discrimination between the members of the tested contrasts in Part II.

c) Part III:

The average score for the discrimination between the members of lax-tense contrasts were grouped by the time of residence, then averaged in order to investigate whether it had an effect on the discrimination between ability in Part III.

3.4.6. The analysis by level of education.

According to the participants' time of residence, the data was further regrouped according to their level of education (Higher or Secondary), then averaged to examine whether level of education had an effect on the discrimination between the members of the tested contrasts.

4. The Results

4.1. Part I: Discrimination by time of residence

The first part of the test required the respondents to listen to two utterances and judge whether they were the same or different words. Only utterance pairs that included word pairs differing in the contrasting lax-tense vowels were taken into account. Three contrasts: /ɐ:/ - /ɐ/, /i:/ - /ɪ/, o:/ - /ɔ/ were tested on three different levels of difficulty.

a) The contrast: /ɐ:/(e.g. "Bart") - /ɐ/ (e.g. "but")

In the first level of difficulty, words "tart" /tɐ:t/ and "tut" /tɐt/ were used, in the second - "bart" /bɐ:t/ and "but" /bɐt/, and in the third – "cart" /kɐ:t/ and "cut" /kɐt/. The results of the discrimination between the vowels /ɐ:/ and /ɐ/ is summarized in Table A1 in appendix A.

b) The contrast: /i:/(e.g. "leave") - /ɪ/(e.g. "live")

In the first level of difficulty words "seat" /si:t/ and "sit" /sɪt/ were used, in the second - "beet" /bi:t/ and "bit" /bɪt/, and in the third – "peat" /pi:t/ and "pit" /pɪt/. The results of the discrimination between the vowels /ɐ:/ and /ɐ/ is summarized in Table A2 in appendix A.

c) The contrast /o:/(e.g. "bought") - /ɔ/ (e.g. "pot")

In the first level of difficulty words "bought" /bo:t/ and "pot" /pɔt/ were used, in the second - "caught" /ko:t/ and "cot" /kɔt/, and in the third – "taught" /to:t/ and "tot" /tɔt/. The results of the discrimination between the vowels /ɐ:/ and /ɐ/ is summarized in Table A3 in appendix A.

4.1.2. The effect of time of residence between the members of the tested contrasts.

The scores for the three contrasts for the each level in test 1 were grouped by the informants' time of residence and then averaged. This data is presented in figures 8-10.

a) The first level:

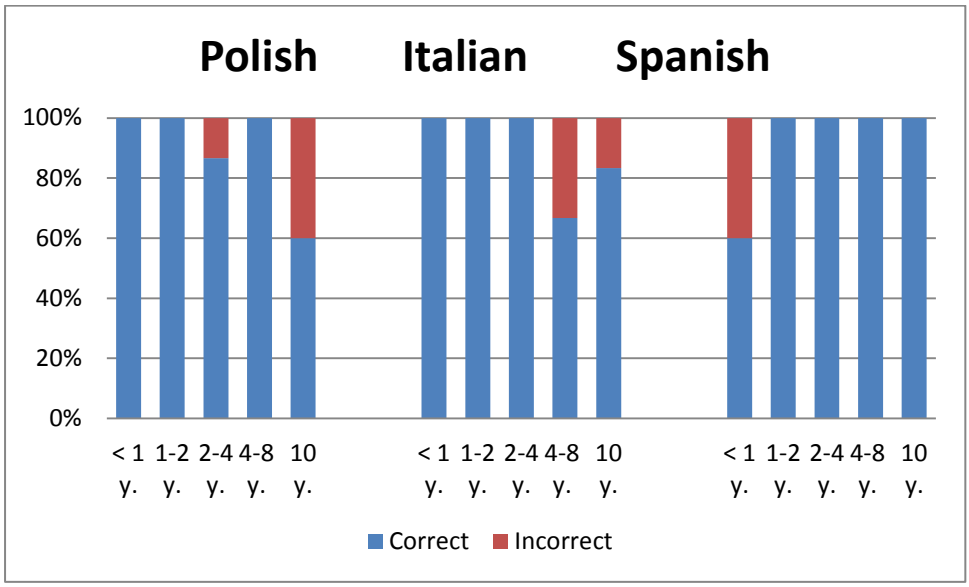


Figure 8. Summary of answers for questions on the first level of difficulty in Test 1 that required informants to recognize the utterances as different words by time of residence.

The data from Figure 8 suggests that time of residence does not have an effect on the discrimination between the members of the tested contrasts. This can be illustrated by the example of Polish and Italian participants whose representatives with the longest time of residence had a higher number of incorrect answers than those with the shorter time (such Polish 10 years onwards or Italian 4-8 and 10 years onwards). However, it must be noted that in case of Spanish speakers, the participants with the shortest time of residence were the only in their language group who did not discriminate the given vowels appropriately.

b) The second level:

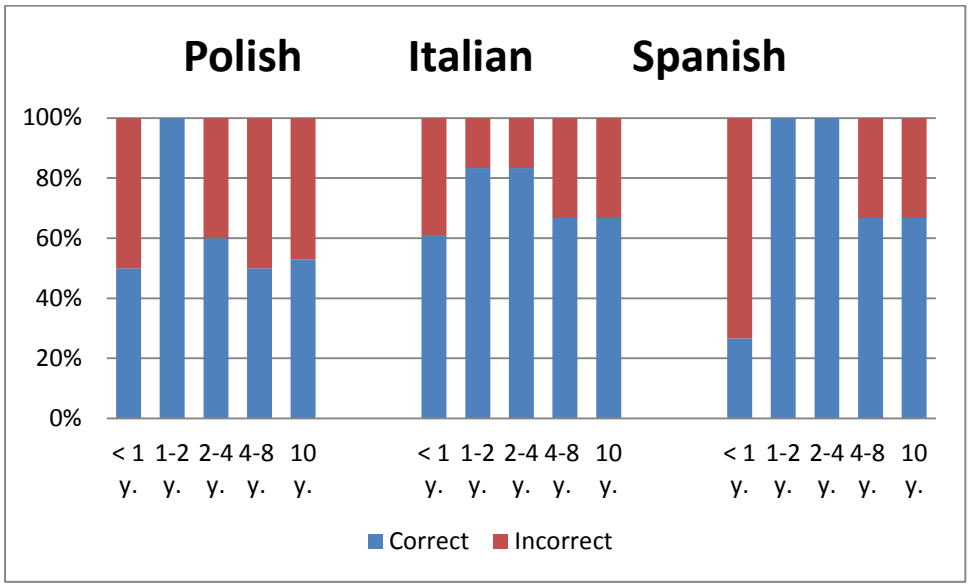


Figure 9. Summary of answers for questions on the second level of difficulty in Test 1 that required informants to recognize the utterances as different words by time of residence.

The data from Figure 9 suggests that time of residence does not have an impact on the discrimination ability between the tested vowels since in all the three language groups the participants of the longer time of residence had lower scores than those of shorter. However, it must be noted that in case of Spanish speakers, those who had lived in Australia for the shortest amount of time showed the greatest number of incorrect answers.

c) The third level:

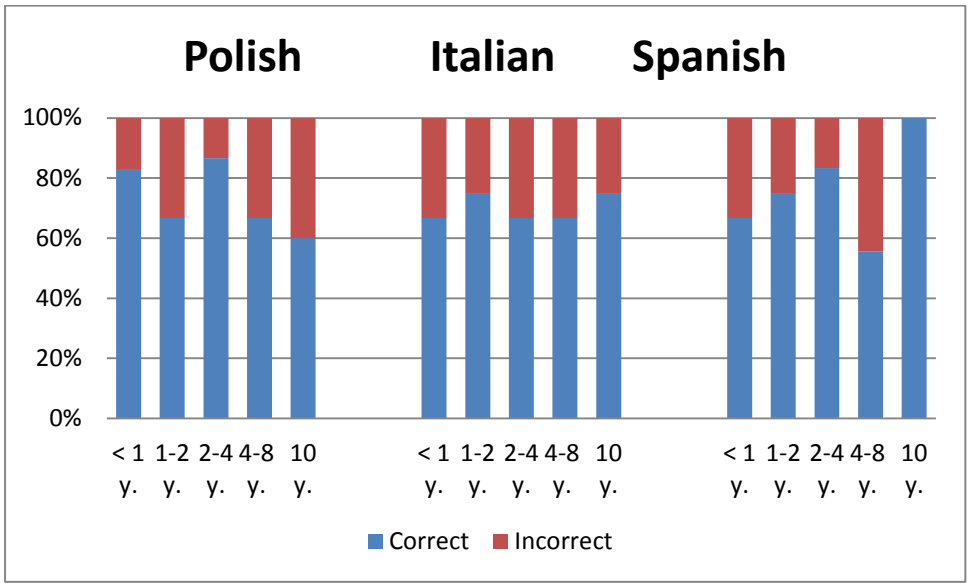


Figure 10. Summary of answers for questions on the third level of difficulty in Test 1 that required informants to recognize the utterances as different words by time of residence.

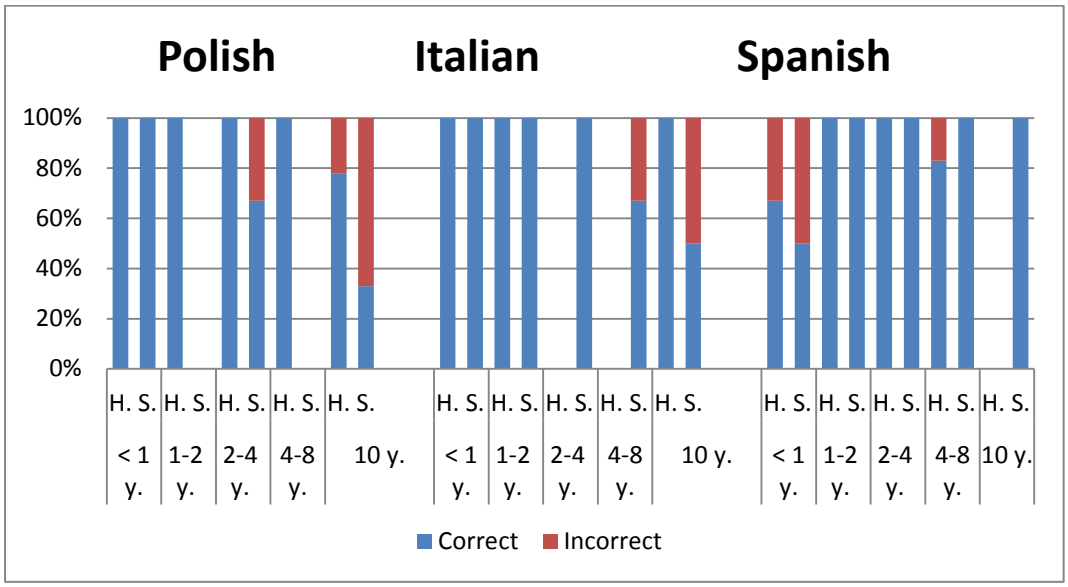
The data from Figure 10 suggests that time of residence does not have an effect on the discrimination between the tested sounds since there are cases in which the representatives with the shorter time of residence have a higher score than those with the longer one such as Polish informants whose time of residence is less than a year outperformed those of 10 years onwards. Moreover, the latter subgroup had the poorest score in their language group. Taking the Italian speakers, the informants whose time of residence is 1-2 years outperformed those of 2-4 and 4-8 years. Also, looking at the Spanish participants, those who had lived in the country for 2-4 years outperformed those who had 4-8 years. However, it must be noted that the Spanish informants of the shortest time of residence had the lowest score in their language group and those of the longest – the highest.

4.1.3. The effect of education on the discrimination between the members of the tested contrasts.

The scores for the three contrasts in each level in test 1 were further grouped by the informants' level of education and then averaged. This data is presented in figures 11-13.

It must be noted that the participants from the following groups were not taken into account in this analysis because they represented only one level of education, thus could not be compared; Polish 1-2 and 4-8 years, Italian 2-4 and 4-8 years, Spanish 10 years and onwards.

a) The first level:

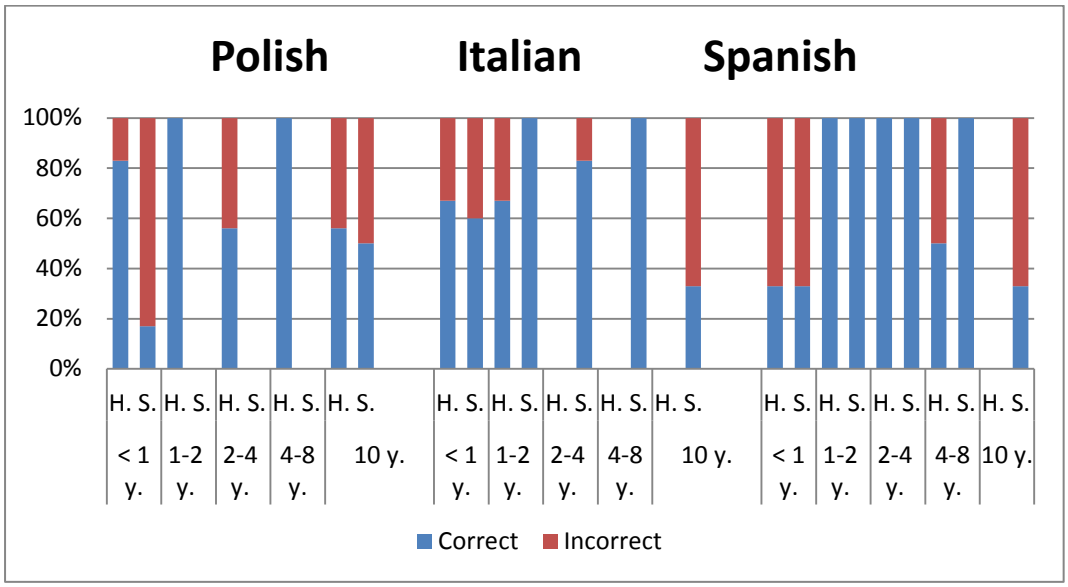


*H=Higher (University) degree *S=Secondary (High-School) degree

Figure 11. Summary of answers for questions on the first level of difficulty in Test 1 that required informants to recognize the utterances as different words by level of education.

The data from Figure 11 suggests that level of education has a positive effect on the discrimination between the members of tested contrasts on the first level. While there is only one case when the participants with the secondary degree outperformed those with the higher degree (Spanish speakers whose time of residence is 4-8 years), there are 4 cases when the informants with the higher degree have higher scores than those with secondary education (Polish speakers – 2-4 and+ 10 y., Italian +10 y., and Spanish <1 y.).

b) The second level:

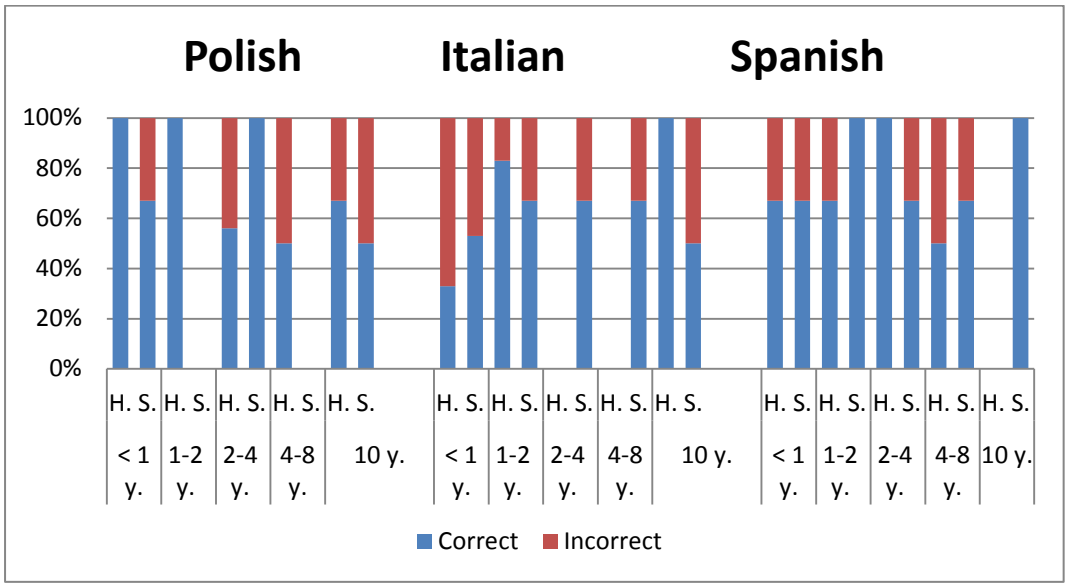


*H=Higher (University) degree *S=Secondary (High-School) degree

Figure 12. Summary of answers for questions on the second level of difficulty in Test 1 that required informants to recognize the utterances as different words by level of education.

The data from Figure 12 suggests that education has a slightly positive effect on the discrimination ability between the members of the tested contrasts on the second level. There are three cases in which the informants with the university degree had the higher score than those with the secondary degree (Polish whose time of residence is less than a year 1, Polish – 10 and onwards, Italian – 10 years and onwards) and two in which the participants with the secondary degree discriminated between the members of the contrast more appropriately than those with the higher degree (Italian – 1-2 years and Spanish - 4-8 years)

c) The third level:



*H=Higher (University) degree *S=Secondary (High-School) degree

Figure 13. Summary of answers for questions on the third level of difficulty in Test 1 that required informants to recognize the utterances as different words by level of education.

The data from the Figure 13 suggests that the level of education has a slightly positive effect on the discrimination ability between the members of the tested contrasts on the third level of difficulty. There are four cases in which the participants with the higher degree outperformed those representatives with the secondary one (Polish whose time of residence is less than one year and 10 years onwards, Italian – 1-2 years and +10 years, Spanish -2-4 years) and three in which the informants with the secondary degree had the higher score than those with the university degree (Polish –-2-4 years, Italian – less than a year and Spanish – 4-8 years).

4.1.4. Summary

The scores for each tested contrast from the three levels of difficulties were averaged in order to obtain an average score for the discrimination ability for each contrast. This data is presented in Table 6.

	/ɐ:/ - /ɐ/	/i:/ - /ɪ/	/o:/ - /ɔ/
Total:	**71.99%**	**72.22%**	**91.55%**
Polish	70.66%	70.33%	92.66%
Italian	72.66%	70.66%	94%
Spanish	72.66%	75.66%	88.66%

Table 6. Summary of the results for the discrimination between the members of the tested contrasts on three levels of difficulty and their average score for each contrast.

Overall, the participants discriminated between the members of the contrast /o:/ - /ɔ/ the most appropriately (91.55%), then between /i:/ and /ɪ/ (72.22%), and lastly between /ɐ:/ - /ɐ/ (71.99%). However, these scores correlate differently when analysed by a particular language group in case of Polish and Italian informants. While they both still perceived the first contrast the most appropriately (Polish - 92.66%, Italian - 94%), they discriminated between the members of the second contrast less appropriately than between the third one (/i:/ - /ɪ/: Polish - 70.33%, Italian - 70.66%, /ɐ:/ - /ɐ/ Polish - 70.66%, Italian - 72.66%).

As presented in sections 4.1.2, the time of residence does not seem to have a great effect on the discrimination ability between the non-native contrasts since the informants with the shorter time of residence in some cases outperformed those with a longer time. However, the level of education as presented in section 4.1.3., has a positive effect on the discrimination ability between the tested sounds. The average scores of the informants' L1 and time of residence groups were analysed according to their level of education and in all three levels of difficulty the participants of the university degree outperformed those of the secondary education.

4.2. Part II: Matching the tested research vowel with the picture/pictures that sound representation has the same sound

This part of test involved the participants to listen to a word containing the tested vowel and then to match it with the picture that sound representation included the same sound. The participants were always given at least two pictures of which one included the same member of the lax-tense contrast and the other one its counterpart. This task required the participants to recall the sound representation of each picture from their lexicon, therefore in order to answer on the questions from Part II, the participants had to have already established categories for the research sounds.

4.2.1 The second type of question.

The second type of question required the informants to listen to a word including the tested research vowel and to match it with a picture that sound representation included the same vowel. They were presented three different pictures of which two included the vowels which were members of the same lax -tense contrast (such as /ɐ:/ - /ɐ/, /i:/ - /ɪ/ and /o:/ - /ɔ/) and one a very different vowel easy to eliminate.

a) The contrast /ɐ:/ (e.g. "Bart") - /ɐ/ (e.g. "but")

The individual vowels /ɐ:/ and /ɐ/ and how they were matched to the picture that sound representation included the same sound were tested in question 26 and 36. In a question 26, the informants heard a word "far" (/fɐ:/) and were presented three different images of "card" (/kɐ:d/), "duck " (/dɐk/) and "book" (/bʊk/). In question 36, the participants heard a word "nuts" (/nɐts/) and had to choose between the pictures of "bus" (/bɐs/), "car" (/kɐ:/) or "bird" (/bɜ:d/).The data on how the participants matched /ɐ:/ and /ɐ/ to the pictures in the second type of question is summarized in Table A4 and A5 in appendix B.

b) The contrast /i:/(e.g. "leave") - /ɪ/ (e.g. "live")

The individual vowels /i:/ and /ɪ/ and how they were matched to the picture whose sound representation included the same sound were tested in question 23 and 38. In a question 23, the informants heard a word "leave" (/li:v/) and were presented three different images of "feet" (/fi:t/), "finger" (/fɪŋgə/), "hair" (/heər/). In question 38, the participants heard a word "live" (/lɪv/) and had to choose between the pictures of "pig" (/pɪg/) "bee" (/bi:/) or "car" (/kɐ:/).The data on how the participants matched /i:/ and /ɪ/ to the picture in the second type of question is summarized in Table A6 and A7 in appendix B.

c) The contrast /o:/(e.g. "bought") - /ɔ/ (e.g. "pot")

The individual vowels /o:/ and /ɔ/ and how they were matched to the picture whose sound representation included the same sound were tested in question 33 and 44. In a question 33, the informants heard a word "horse" (/ho:s/) and were presented three different images of "corn" (/ko:n/), "coffee" (/kɔfi:/) and "sad" (/sæd/).In question 44, the participants heard a word "got" (/gɔt/) and had to choose between the pictures of "dog" (/dɔg/) "door" (/do:/) or "tree" (/tri:/).. The data on how the participants matched /o:/ and /ɔ/ to the pictures in the second type of question is summarized in Table A8 and A9 in appendix B.

d) Summary

Overall, the participants, discriminated best between /ɐ:/ and /ɐ/ (58.83%), then between /o:/ and /ɔ/ (55.39%) and lastly between /i:/ and /ɪ/ (48.83%). However, these scores correlated differently when analysed by the language groups. For example, the Polish speakers had the highest and equal score for contrasts /o:/ - /ɔ/ and /i:/ - /ɪ/ (64%) and then for /ɐ:/ - /ɐ/ (61%). The Italian informants discriminated best between /o:/ and /ɔ/ (59%), then between /ɐ:/ and /ɐ/ (55.5%) and lastly between /i:/ - /ɪ/. The Spanish participants, however, had the highest score for the contrast /ɐ:/ - /ɐ/ (60%) and then equal one for /i:/ - /ɪ/ and /o:/ - /ɔ/ (53%). Those numbers were derived by adding the

correct answers for each member of the lax-tense contrast and then by averaging. This data is presented in Table 7.

2nd type of question	/ɐ:/ - /ɐ/			/i:/ - /ɪ/			/o:/ - /ɔ/		
	/ɐ:/	/ɐ/	Average	/i:/	/ɪ/	Average	/o:/	/ɔ/	Average
Total:	**52.33%**	**65.33%**	**58.83%**	**59.78**	**37.87%**	**48.83%**	**55%**	**55.78%**	**55.39%**
Polish	50%	72%	**61%**	72%	56%	**64%**	67%	61%	**64%**
Italian	47%	64%	**55.5%**	59%	29%	**44%**	47%	71%	**59%**
Spanish	60%	60%	**60%**	73%	33%	**53%**	73%	33%	**53%**

Table 7. The summary of correct answers that involved the informants to match the tested vowels to the picture with the same sound in the second type of question.

4.2.2 The third type of question

The third type of question required the informants to listen to a word including the tested research vowel and to match it with a picture whose sound representation included the same vowel. However, this time they were presented with three different pictures which all included members of a particular research contrast (such as /ɐ:/ - /ɐ/, /i:/ - /ɪ/ and /o:/ - /ɔ/). There was only one picture that included the tested sound and the other two included its counterpart. Therefore for example, if a heard word included the tense vowel, one of the pictures' sound representations had the tense member and the other two – lax.

a) The contrast /ɐ:/ (e.g. "Bart") - /ɐ/ (e.g. "but"):

The individual vowels /ɐ:/ and /ɐ/ and how they were matched to the right picture were tested in question 29 and 24. In a question 29, the informants heard a word "arm" (/ɐ:m/) and were presented images of "card" (/kɐ:d/), "duck " (/dɐk/) and "sun" (/sɐn/). In question 24, the participants heard a word "truck" (/trɐk/) and had to choose between the pictures of "bus" (/bɐs/), "card" (/kɐ:d/) or "heart" (/hɐ:t/). The data on how the participants matched /ɐ:/ and /ɐ/ to the picture in the third type of question is summarized in Table A10 and A11 in appendix B.

b) The contrast /i:/ (e.g. "leave") - /ɪ/ (e.g. "live")

The individual vowels /i:/ and /ɪ/ and how they were matched to the right picture that sound representation included the same sound were tested in question 40 and 43. In a question 40, the informants heard a word "feed" (/fi:d/) and were presented images of "bee" (/bi:/), "pig " (/pɪg /) and "mirror" (/mɪrər /). In question 43, the participants heard a word "thick" (/θɪk/) and had to choose between the pictures of "key" (/ki:/), "sing" (/sɪŋ/) or "cheese" (/tʃi:z /). The data on how the participants matched /i:/ and /ɪ/ to the pictures in the third type of question is summarized in Table A12 and A13 in appendix B.

c) The contrast /o:/ (e.g. "bought") - /ɔ/ (e.g. "pot")

The individual vowels /o:/ and /ɔ/ and how they were matched to the picture that sound representation included the same sound were tested in question 28 and 46. In a question 28, the informants heard a word "call" (/ko:l/) and were presented images of "door" (/do:/), "mop" (/mɔp/) and "coffee" (/kɔfi:/). In question 46, the participants heard a word "sock" (/sɔk/) and had to choose between the pictures of "dog" (/dɔg/), "corn" (/ko:n/) or "ball" (/bo:l/)..The data on how the participants matched /o:/ and / ɔ / to the pictures in the third level is summarized in Table A14 and A15 in appendix B.

d) Summary

Overall, the informants discriminated best between the members of the contrast /i:/ - /ɪ/ , then between /o:/ - /ɔ/ (43.50%) and lastly - /ɐ:/ - /ɐ/ (28.50%). However, those scores correlated differently in case of Spanish speakers when analysed by language group. Those informants had the highest score for the contrast /o:/ - /ɔ/ (56.5%), then for /i:/ - /ɪ/ (43%) and the lowest for /ɐ:/ - /ɐ/ (23%).Those numbers were derived by adding the correct answers for each member of the lax-tense contrast and then by averaging. This data is presented in Table 8.

3rd type of question	/ɐ:/ - /ɐ/			/i:/ - /ɪ/			/o:/ - /ɔ/		
	/ɐ:/	/ɐ/	Average	/i:/	/ɪ/	Average	/o:/	/ɔ/	Average
Total:	**27%**	**30%**	**28.5%**	**63.33%**	**51.33%**	**57.33%**	**51%**	**36%**	**43.5%**
Polish	50%	28%	**39%**	72%	50%	**61%**	39%	44%	**41.5%**
Italian	18%	29%	**23.5%**	65%	71%	**68%**	41%	24%	**32.5%**
Spanish	13%	33%	**23%**	53%	33%	**43%**	73%	40%	**56.5%**

Table 8. The summary of correct answers that involved the informants to match the tested vowels to the picture with the same sound in the third type of question.

4.2.3. The fourth type of question

The fourth type of question involved the informants to listen to a word including the research vowel and then to match it with the two pictures that included the same sound. The participants were presented three different pictures of which two included the same research vowel and the one –the other member, counterpart sound, from the lax-tense contrast.

a) The contrast /ɐ:/ (e.g. "Bart") - /ɐ/ (e.g. "but")

The individual vowels /ɐ:/ and /ɐ/ and how they were matched to two pictures that sound representation included the same sound were tested in question 42 and 41. In a question 42, the informants heard a word "farm" (/fɐ:m/) and were presented images of "heart" (/hɐ:t/), "car" (/kɐ:r/) and "bus" (/bɐs/). In question 41, the participants heard a word "cup" (/kɐp/) and had to choose between the pictures of "sun" (/sɐn/), "bus" (/bɐs/) or "car" (/kɐr/). The data on how the participants

matched /ɐ:/ and /ɐ/ to the pictures in the fourth type of question is summarized in Table A16 and A17 in appendix B.

b) The contrast /i:/(e.g. "leave") - /ɪ/ (e.g. "live")

The individual vowels /i:/ and /ɪ/ and how they were matched to two pictures that sound representation included the same sound were tested in question 30 and 45. In a question 30, the informants heard a word "feet" (/fi:t/) and were presented images of "tree" (/tri:/), "bin" (/bɪn/) and "cheese" (/ʧi:z/). In question 45, the participants heard a word "bit" (/bɪt/) and had to choose between the pictures of "pig" (/pɪg/), "bee" (/bi:/) or "sing" (/sɪŋ/). The data on how the participants matched /ɐ:/ and /ɐ/ to the pictures in the fourth type of question is summarized in Table A18 and A19 in appendix B.

c) The contrast /o:/ (e.g. "bought") - /ɔ/ (e.g. "pot")

The individual vowels /o:/ and /ɔ/ and how they were matched to two pictures that sound representation included the same sound were tested in question 31 and 35. In a question 31, the informants heard a word "fought" (/fo:t/) and were presented images of "corn" (/ko:n/), "horse" (/ho:s/) and "dog" (/dɔg/). In question 35, the participants heard a word "tot" (/tɔt/) and had to choose between the pictures of "sock" (/sɔk/), "corn" (/ko:n/) or "pot" (/pɔt/). The data on how the participants matched /ɐ:/ and /ɐ/ to pictures in the fourth type of question is summarized in Table A20 and A21 in appendix B.

d) Summary

Overall, the participants discriminated between the members of the contrast /ɐ:/ - /ɐ/ the most appropriately (37.33%), then between /o:/ - /ɔ/ (32.17%) and lastly /i:/ - /ɪ/ (37.33%). However, these scores correlate differently when analysed by the language groups. The Polish and Italian speakers had the highest score for the contrast /ɐ:/ - /ɐ/ (Polish 58.5%, Italian 27%), then for /i:/ - /ɪ/ (Polish 55.5%, Italian 24%) and the lowest for /o:/ - /ɔ/ (Polish 53%, Italian 23.5%). The Italian informants also discriminated between the members of the contrast /ɐ:/ - /ɐ/ (26.5%) the most appropriately, however had higher score for the contrast /o:/ - /ɔ/ (20%) than for /i:/ - /ɪ/ (10%). Those numbers were derived by adding the correct answers for each member of a particular lax-tense contrast and then by averaging. This data is presented in Table 9.

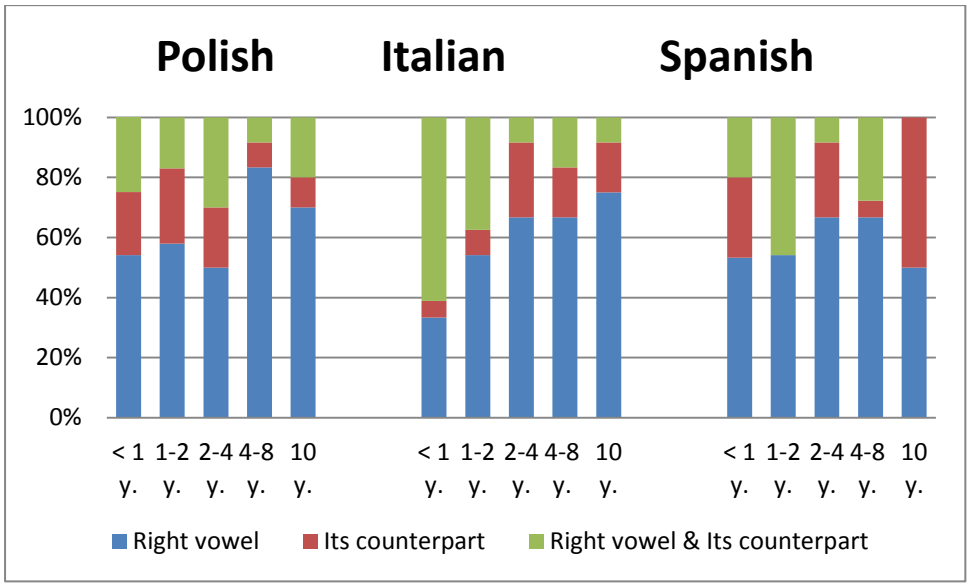
4th type of question	/ɐ:/ - /ɐ/			/i:/ - /ɪ/			/o:/ - /ɔ/		
	/ɐ:/	/ɐ/	Average	/i:/	/ɪ/	Average	/o:/	/ɔ/	Average
Total:	**43.33%**	**31.33%**	**37.33%**	**35%**	**24.67%**	**29.84%**	**23%**	**41.33%**	**32.17%**
Polish	67%	50%	**58.5%**	61%	50%	**55.5%**	50%	56%	**53%**
Italian	30%	24%	**27%**	24%	24%	**24%**	12%	35%	**23.5%**
Spanish	33%	20%	**26.5%**	20%	0%	**10%**	7%	33%	**20%**

Table 9. Summary of correct answers that involved the informants to match the tested vowels to the picture with the same sound in the fourth type of question.

4.2.4. An effect of time of residence on the discrimination ability between the members of the tested contrasts

The scores for the three contrasts for the second, third and fourth of type of question were test 2 were grouped by the informants' time of residence and then averaged. This data is presented in figures 14-16.

a) The Second Type of question



*Right vowel & Its counterpart = 2 pictures which sound representation included both members of the tested contrast

Figure 14. The Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the second type of question by time of residence.

The data from Figure 14 suggests that time of residence does not have a great effect on the discrimination between the members of the tested contrasts. It must be noted that the informants of the time of residence less than a year and 1-2 years have lower score than others. However, there cannot be observed the patterns that with the longer time of residence the better discrimination between the members since for example in case of Polish and Spanish speakers, the participants whose time of residence is 4-8 years outperformed those of 10 years onwards.

b) The third type of question.

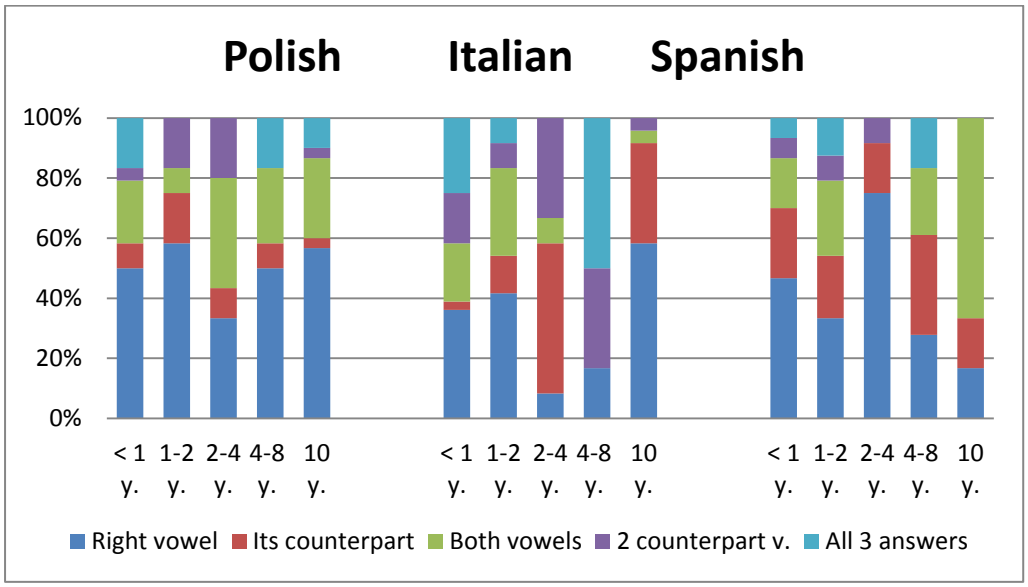


Figure 15. Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the third type of question by time of residence.

In the data from Figure 15, there cannot be observed any pattern confirming that with the longer time of residence the discrimination ability between the members of the tested contrasts decreases. For example, the Spanish speakers of the time of the shortest time of residence have significantly higher score than those of the longest one or the Italian informants who had lived in the L2 country for less than a year discriminated between the sounds much more appropriately than those who had lived for 2-4 years.

c) The fourth type of question.

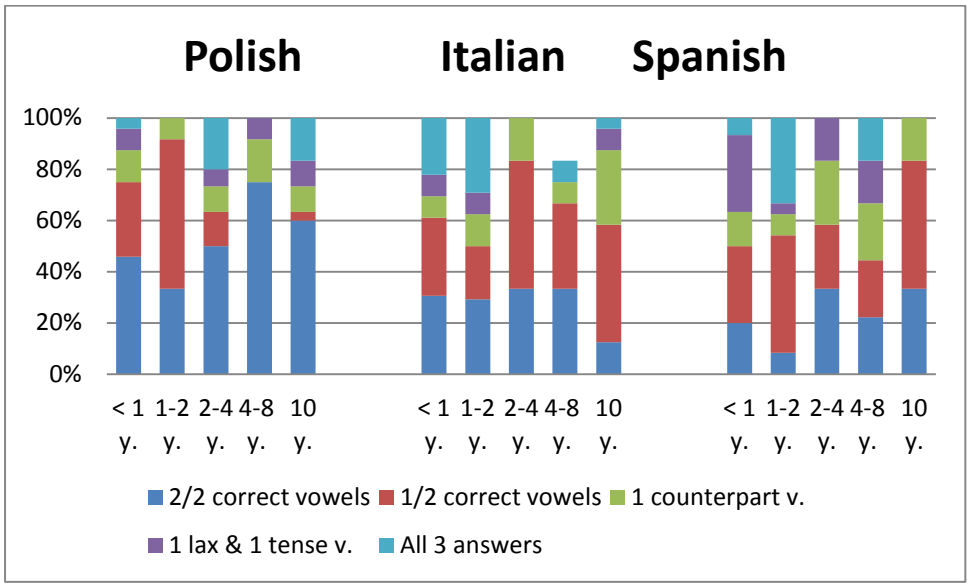


Figure 16. Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the fourth type of question by time of residence.

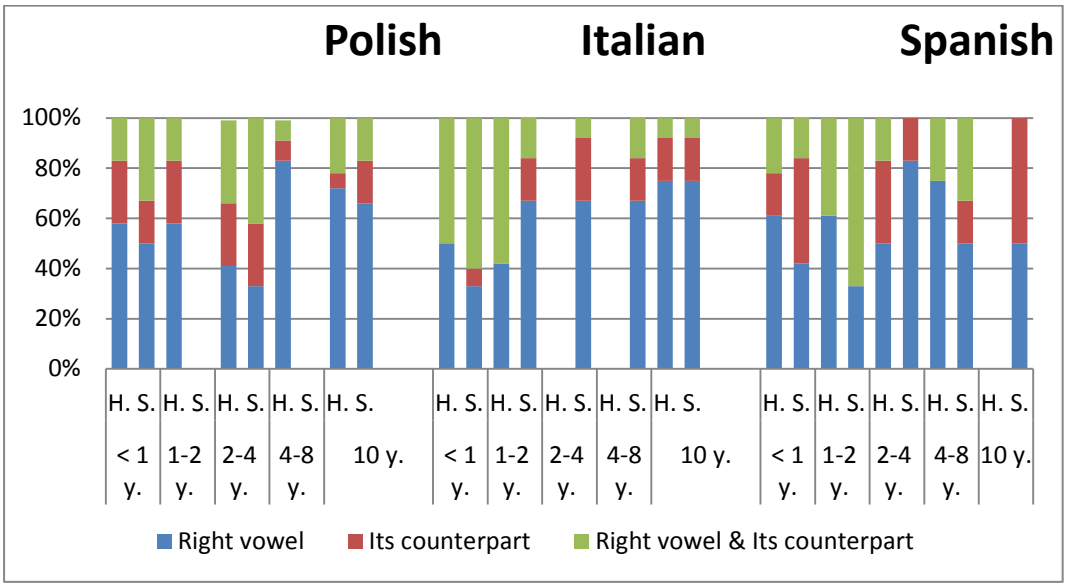
The data from Figure 16 suggests that time of residence does not have a great effect on the discrimination between the members of the tested contrasts since there cannot be observed pattern for the decreasing ability to perceive the research sounds in a native-like way. For example, the Italian speakers of the shortest time of residence had higher score than those of the longest. It must be noted, that in case of Polish and Spanish informants those of time of residence less than a year performed poorer than those of 10 years onwards.

4.2.5. An effect of education level on the discrimination ability between the members of the tested contrasts.

The average scores for the three contrasts for the second, third and fourth of type of question by the time of residence in test 2 were further grouped by the informants' level of education and then averaged. This data is presented in figures 17-19.

It must be noted that the participants from the following groups were not taken into account in this analysis because they represented only one level of education, thus could not be compared; Polish 1-2 and 4-8 years, Italian 2-4 and 4-8 years, Spanish 10 years and onwards.

a) The Second Type of question

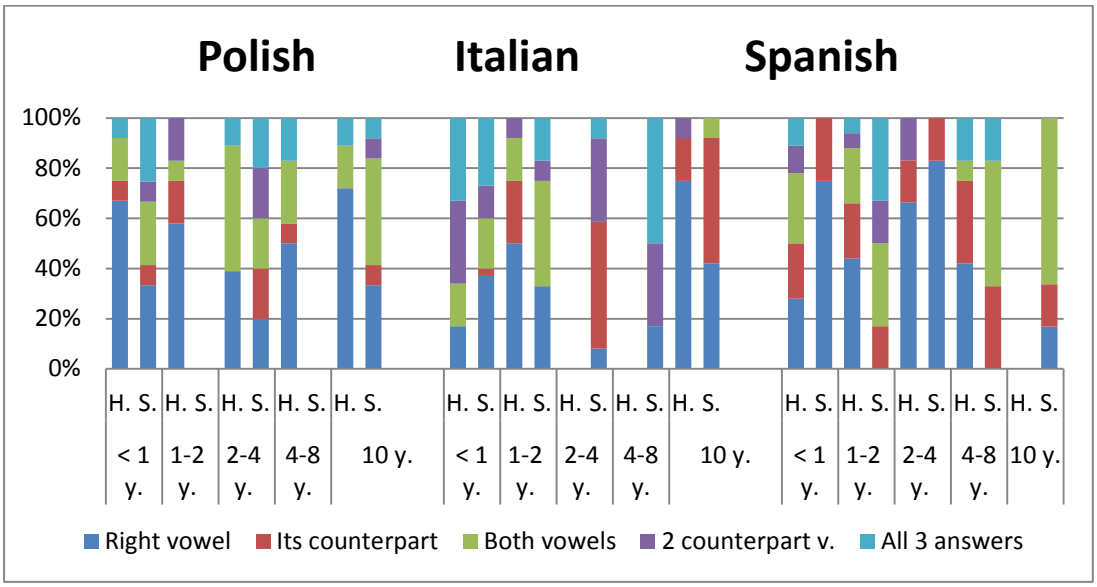


*H= Higher (University) Degree *S=Secondary (High-School) Degree
*Right vowel & Its counterpart = 2 pictures which sound representation included both members of the tested contras

Figure 17. The Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the second type of question by level of education.

The data from Figure 17 suggests that the level of education has a positive effect on discrimination ability between the members of the tested contrasts. There are seven cases in which the informants with the higher degree outperformed those with the secondary one (Polish whose time of residence is less than a year, Polish – 2-4 years, Polish +10 years, Italian – less than a year, Spanish – less than a year, Spanish, 1-2 years, Spanish – 4-8 years) and 2 in which the participants with the secondary degree had the higher score than those with the university degree (Italian – 1-2 years, Spanish – 2-4 years).

b) The Third Type of question

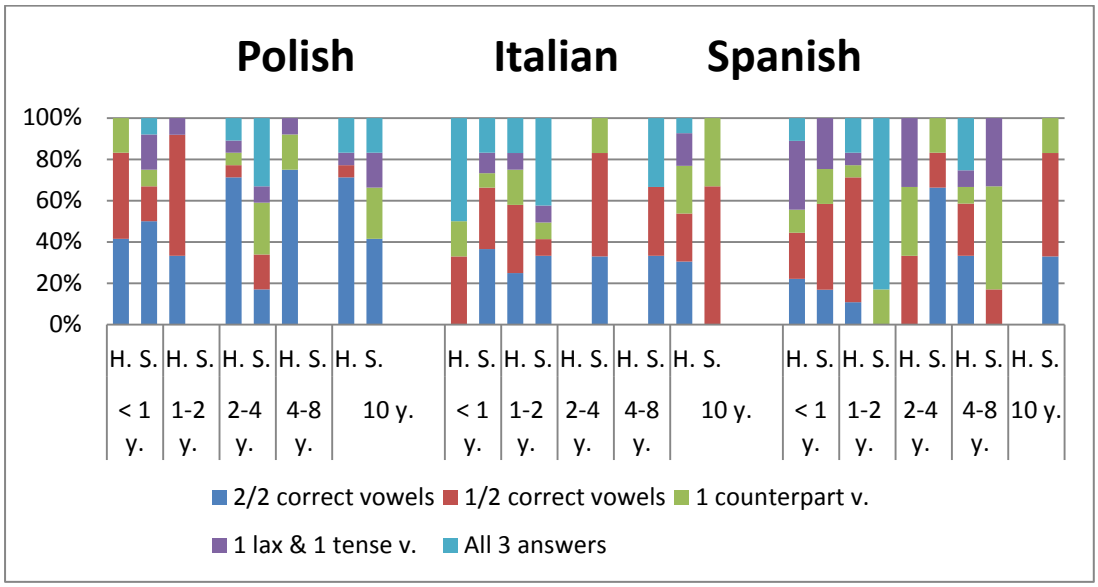


*H= Higher (University) Degree *S=Secondary (High-School) Degree

Figure 18. Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the third type of question by level of education.

The data from Figure 18 suggests that the education level has a positive effect on the discrimination ability between the members of the tested contrasts in the third type of question. There are seven cases in which the participants with the university degree had the higher score than those with the secondary one (Polish whose time of residence is less than a year, Polish – 2-4 years, Polish – 10 years and onwards, Italian – 1-2 years and 10 years or more, Spanish – 1-2 years, 4-8 years) and 3 in which the informants with the secondary degree outperformed those with the higher degree (Italian - less than a year, Spanish – less than a year and 2-4 years).

c) The fourth type of question



*H= Higher (University) Degree *S=Secondary (High-School) Degree

Figure 19. Summary of answers for questions in which informants had to match the tested vowel with the picture including the tested sound in the fourth type of question by level of education.

The data from Figure 19 suggests that education level has positive effect on the discrimination ability in the fourth type of question. There are 6 cases in which the informants with the higher degree outperformed those with the secondary one (Polish whose time of residence is 2-4 and + 10 years, Italian + 10 years, Spanish – less than a year, 1-2 and 4-8 years) and 4 in which the participants with the secondary degree had the higher score than those with the university degree (Polish- less than a year, Italian – less than a year and 1-2 years, Spanish 2-4 years).

4.2.6. Summary

Table 10 gives the average from the questions matching the tested vowels with the correct picture.

Average score:	/ɐ:/ - /ɐ/			/i:/ - /ɪ/			/o:/ - /ɔ/		
	/ɐ:/	/ɐ/	Average	/i:/	/ɪ/	Average	/o:/	/ɔ/	Average
Total:	**40.83%**	**42.22%**	**41.52%**	**55.44%**	**38.44%**	**46.94%**	**45.44%**	**41.11%**	**43.28%**
Polish	55.66%	50%	**53.33%**	68.33%	52%	**60.17%**	52%	53.67%	**52.84%**
Italian	31.66%	39%	**35.33%**	49.33%	41.33%	**45.33%**	33.33%	43.33%	**38.33%**
Spanish	35.33%	37.66%	**36.50%**	48.67%	22%	**35.34%**	51%	35.33%	**43.17%**

Table 10. Summary of the results of matching the tested vowel with its right picture/pictures by a language group.

Overall, the members of the contrast of /i:/ - /ɪ/ were the best discriminated (46.94%), /o:/ - /ɔ/ were second the best (43.28%) and /ɐ:/ - /ɐ/ was the (41.52%). However, it must be noted when analysing the data by the particular language, the scores correlated differently in case of Spanish and

Polish informants. The Polish participants discriminated the most appropriately between /i:/ - /ɪ/ (60.17%), then /ɐ:/ - /ɐ/ (53.33%) and lastly between /o:/ - /ɔ/ (52.84%). Spanish, on the other hand, discriminated the most appropriately between the members of the contrast /o:/ - /ɔ/ (43.17%), then /ɐ:/ - /ɐ/ (36.50%.) , and lastly - /i:/ - /ɪ/ (35.34%).

The data from the tables included in section 4.2.4 suggests that the time of residence does not have a great impact on the discrimination ability between the members from the tested contrasts. However, according to the data from the tables in section 4.2.5, the level of education seems to have a positive effect since the participants with the university degree have higher scores in all the three types of question than those with the secondary one.

4.3. Part III: Matching the tested vowel with its orthographic representation

In the last part of the test the informants had to listen to a sentence which they were also presented in the written form, however which lacked the word with the tested vowel. The respondents were given 2 or 3 different words which varied only in the vowel and had to choose which one they heard. It was also possible for the participants to match more than one correct answer if they thought that some words are homonymous.

a) The contrast /ɐ:/ (e.g. "Bart") - /ɐ/ (e.g. "but")

There were 6 questions that tested contrast /ɐ:/ - /ɐ/. They included exactly the same words but were testing different vowels. For example in question 48, the participants were given words "cart" /kɐ:t/, "cut" /kɐt/ or "cat" /kæt/, in question 54 - "tart" /tɐ:t/, "tut" /tɐt/ or "tat" /tæt/ and in question 60 - "bart" /bɐ:t/, "but" /bɐt/ or "bat" /bæt/ and in all the three the respondents heard words with /ɐ:/ and had to pick those written words that represented the tested vowel . The other three questions included exactly the same three sets of words; however this time the informants heard words with the lax member of the contrast /ɐ/ (question 52, 57, 63). The answers for all the six questions were cumulated and calculated into percentage. The data on how the informants matched /ɐ:/ and /ɐ/ to their orthographies is summarized in Table A22 and A23 in appendix C.

b) The contrast /i:/(e.g. "leave") - /ɪ/ (e.g. "live")

There were 6 questions that tested the contrast /i:/ - /ɪ /. They included exactly the same words but were testing different vowel. For example in question 47, the participants were given the words "seat" /si:t/, "sit" /sɪt/, in question 53 - "peat" /pi:t/, "pit" /pɪt/ and in question 59 - "beet" /bi:t/, "bit" /bɪt/ and in all the three the respondents heard words with the tense sound and had to pick those containing that vowel. The other three questions included exactly the same three word pairs; however this time the informants heard words with the lax member of the contrast /ɪ/ and which were the

correct answers for questions: 62, 56, 50. The answers for all the six questions were cumulated and calculated into percentage. The data on how the participants matched /i:/ and are /ɪ / is summarized in Table A24 and A25 in appendix C.

c) The contrast /o:/ (e.g. "bought") - /ɔ/ (e.g. "pot")

There were 6 questions that tested contrast /o:/ - /ɔ/ . Three of them included exactly the same words but were testing different vowels. For example in question 49, the participants were given words "caught" /ko:t/, "cot" /kɔt/, in question 58 - "taught" /to:t/, "tot" /tɔt/ and in question 64 - "nought" /no:t/, "not" / nɔt/ and in all the three the respondents heard words with /o:/ and had to pick those containing that vowel . The other three questions included exactly the same three word pairs; however this time they heard words with the lax member of the contrast /ɔ/ and which correct answers for questions were: 55, 51, and 61. The answers for all the six questions were cumulated and calculated into percentage. The results for questions testing /o:/ are summarized in Table A26 and /ɔ/ in Table A27 in appendix C.

4.3.1. An effect of time of residence on the discrimination ability between the members of the tested contrasts

The scores for the members of the three contrasts in test 3 were grouped by the informants' time of residence and then averaged. This data is presented in figures 20 - 21.

a) The contrast /i:/ (e.g. "leave")- /ɪ/ (e.g. "live") and /o:/ (e.g. "bought")- /ɔ/ (e.g. "pot")

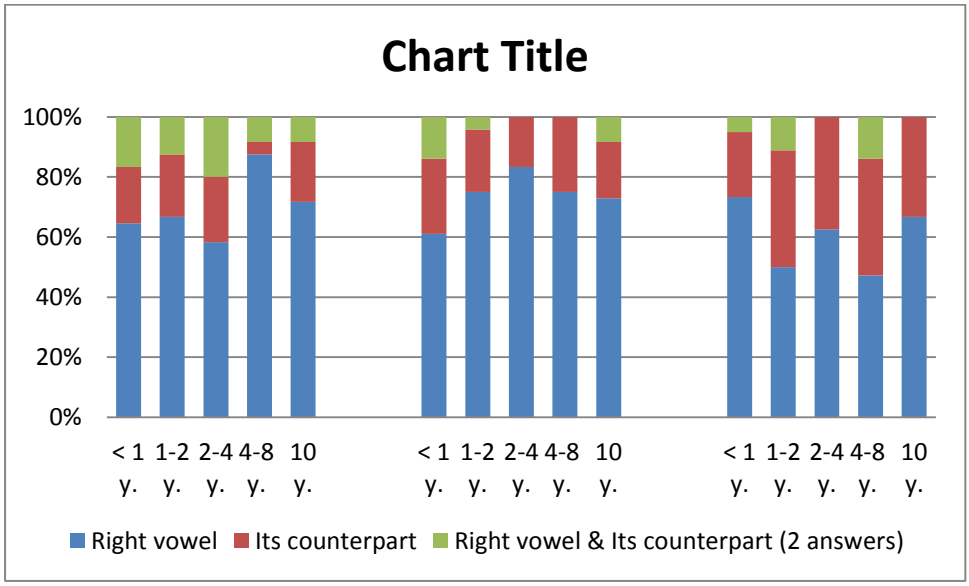


Figure 20. Summary of answers matching the tested vowels of contrasts /i:/ - /ɪ/ and /o:/ - /ɔ/ with their orthographies by time of residence.

The data from Figure 20 suggests that time of residence does not have a great impact on the discrimination between the members of the contrasts /i:/ - /ɪ/ and /o:/ - /ɔ/. However it must be noted that in case of Polish and Italian speakers, the participants with the longest time of residence had higher score than those with the shortest time. The Spanish informants of time of residence less than one year perceived the contrast the most appropriately in their language group.

b) The contrast: /ɒ:/ (e.g. "Bart") - /ɒ/ (e.g. "but")

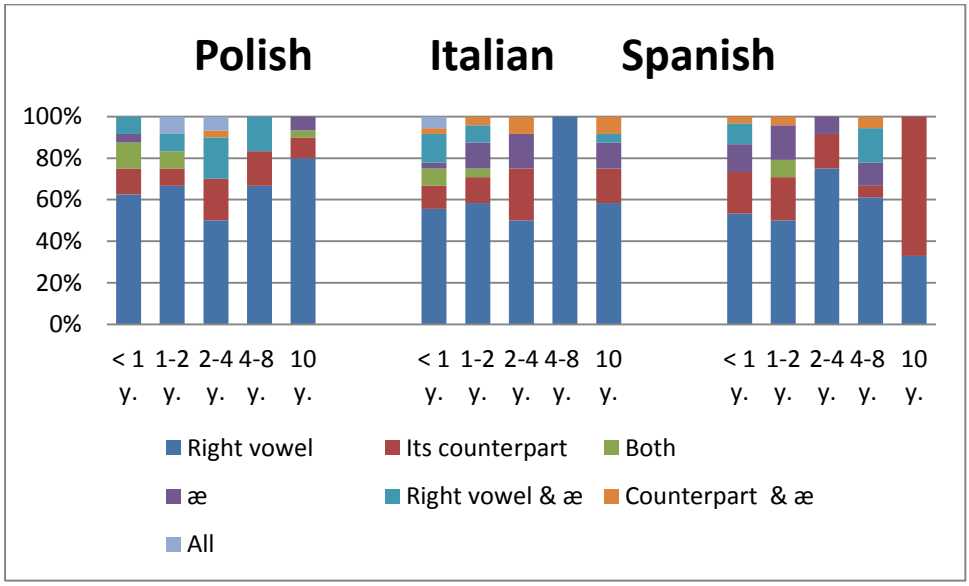


Figure 21. Summary of answers matching the tested vowels of contrast /ɒ:/ - /ɒ/ with the orthographies by time of residence.

The data from Figure 21 suggests that time of residence does not have a great impact on the discrimination ability between the members of the /ɐ:/ - /ɐ/ since for example in case of Spanish speakers those with the longest time residence matched the tested vowels from that contrast the least appropriately from their group. Moreover, the informants who had lived in Australia for less than a year had a higher score than those for 1-2 years or those who had lived for 2-4 years outperformed those -4-8 years. On the other hand, taking the Polish group the participants of the longest time of residence had the highest score for discrimination of this contrast. It must be also noted that the Polish and Italian speakers who had lived in Australia for less than a year had the higher score than those for 2-4 years. There cannot be observed any regular pattern confirming an effect of time of residence for matching the members to their orthographies.

4.3.2. An effect of level of education on the discrimination ability between the members of the tested contrasts.

The scores for matching the individual members of the same contrasts were added to each other and then averaged in order to investigate whether the level of education had a positive effect in Part III.

It must be noted that the participants from the following groups were not taken into account in this analysis because they represented only one level of education, thus could not be compared; Polish 1-2 and 4-8 years, Italian 2-4 and 4-8 years, Spanish 10 years and onwards.

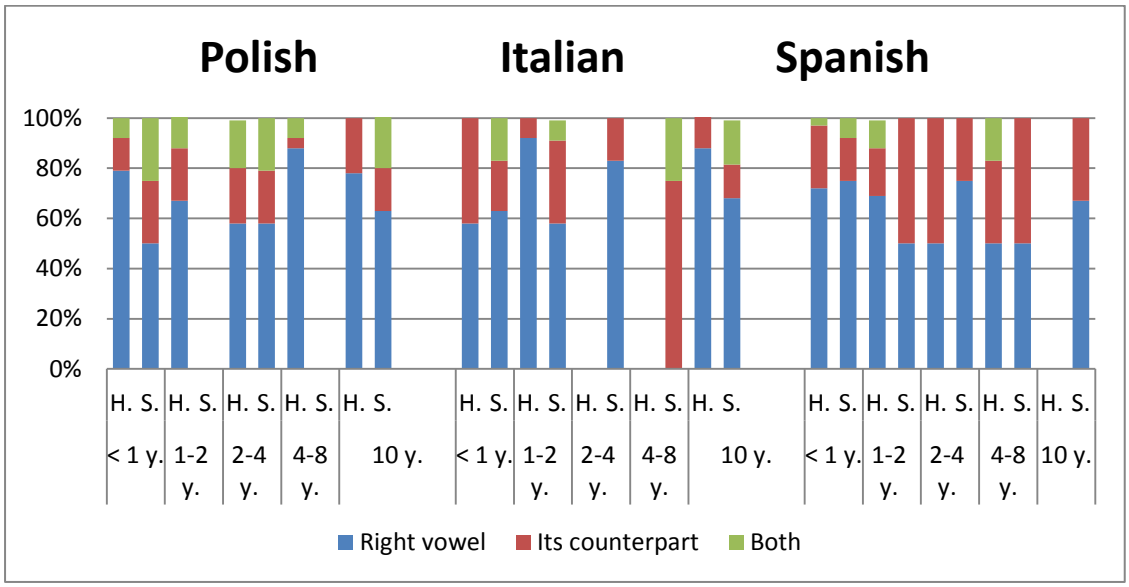


Figure 22. The summary on matching the contras/iː/ - /ɪ/ and /oː/ - /ɔ/ *with its orthography by the level of education.*

The data from Figure 22, suggests that education has a positive effect on the discrimination ability between the members of the tested contrasts: /iː/ - /ɪ/ and /oː/ - /ɔ/. There are 5 cases in which the informants with the university degree had the higher number of correct answers than those with the secondary degree (Polish whose time of residence is less than a year and + 10 years, Italian 1-2 and + 10 years, Spanish 1-2 years) and 3 in which the participants with the secondary degree outperformed those with the higher one (Italian - less than a year, Spanish - less than a year and 2-4 years).

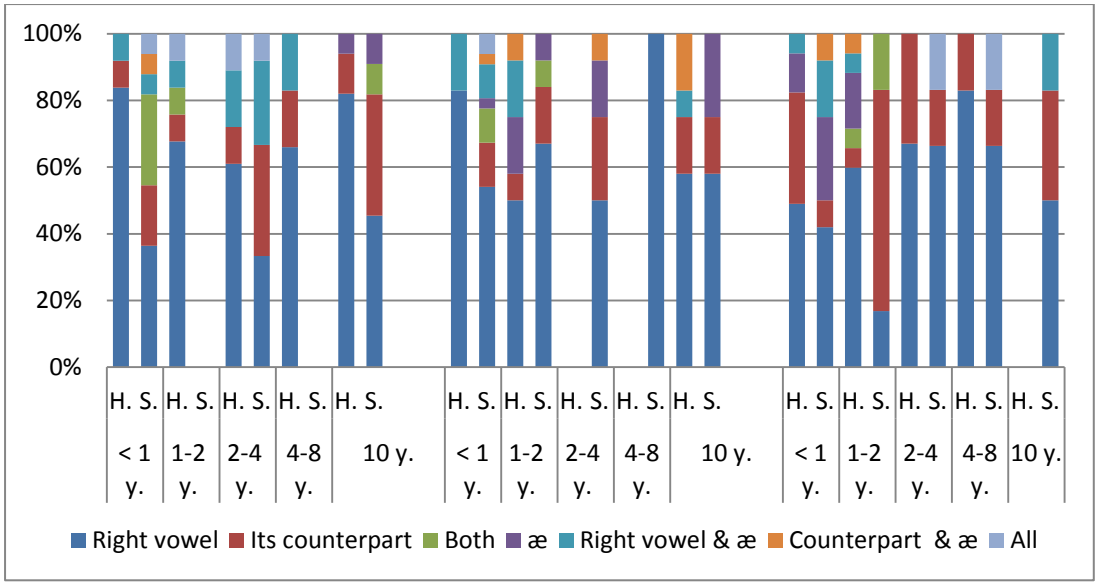


Figure 23. Summary on matching the contrast /ɐ:/ - /ɐ/ with its orthography by the level of education.

The data from Figure 23 suggests that the education level has a positive effect on the discrimination ability between the members of the contrast /ɐ:/ - /ɐ/. There are 7 cases in which the participants with the higher degree outperformed those with the secondary one (Polish whose time of residence is less than a year, 2-4 years and + 10 years, Italian – less than a year, Spanish – less than a year, 1-2 years, 4-8 years) and one in which the informants with the high school degree had a higher score than those with university degree (Italian – 1-2 years).

4.3.3 Summary

The scores on the appropriate vowel matching with its orthography for both members in each contrast were cumulated in order to get an average score. This data is presented in Table 11,

	/ɐ:/ - /ɐ/			/i:/ - /ɪ/			/o:/ - /ɔ/		
	/ɐ:/	/ɐ/	Average	/i:/	/ɪ/	Average	/o:/	/ɔ/	Average
Total:	**57%**	**57.33%**	**57.17%**	**61%**	**61%**	**61%**	**80.67%**	**53%**	**66.83%**
Polish	63%	69%	66%	65%	65%	65%	83%	44%	63.5%
Italian	59%	54%	56.5%	65%	65%	65%	82%	51%	66.5%
Spanish	49%	49%	49%	53%	53%	53%	76%	64%	70%

Table 11. Summary on matching the tested vowels with their orthographies.

The data from Table 11 suggests that the participants generally discriminated best between the members of /oː/ - /ɔ/ (66.83%), then between /iː/ - /ɪ/ (66%) and /ɐː/ - /ɐ/ (57.17%). However, when analysed by a language group, the Polish informants' results correlated differently. They had the highest score for the contrast /ɐː/ - /ɐ/ (66%), then for /iː/ - /ɪ/ (65%) and lastly for /oː/ - /ɔ/ (63.5%).

The data from the tables included in section 4.3.1 suggest that time of residence does not have a great impact on the discrimination ability between the members of the tested contrasts. However, the education level does seem to have a positive effect since the participants with the higher degree get higher scores than those with the secondary one as presented in section 4.3.2.

4.4. Summary of the whole research

The scores for correct discrimination between the members of the tested contrasts from the three tests averaged in order to establish which contrast was generally perceived the most appropriately, which less appropriately and which the least. This data is presented in Table12.

Contrast:	/ɐː/ - /ɐ/	/iː/ - /ɪ/	/oː/ - /ɔ/
As one group:	**56.96%**	**60.06%**	**67.84%**
Polish	63.33%	65.17%	69.97%
Italian	54.83%	60.33%	66.27%
Spanish	52.72%	54.67%	67.28%

Table 12. The overall average score for each tested contrast and by the language groups.

The data from Table 12 suggests that the phonetic differences cumulate for L2 perception and the more phonetic differences there are between the members of the tested contrasts, the more native-like perception is. This can be illustrated by the example of the /oː/ - /ɔ/ (3 phonetic differences) being the best discriminated by the all language group, then /iː/ - /ɪ/ 2 phonetic differences) and lastly /ɐː/ - /ɐ/ (1 phonetic difference).

The time of residence does not seem to have an impact on the discrimination ability between the contrasting sounds, however the level education does since in most cases the participants with the higher degree outperformed those with the lower degree.

5. Discussion

According to Best's categorization of non-native contrasts, all the three contrasts tested in the study are an examples of *Category-Goodness Difference* in which one member of the L2 contrast is "acceptable" and other "deviant" (1995). In case of the contrast /oː/ - /ɔ/ and / ɐː/ - /ɐ/, /ɔ/ and /ɐ/ are the example of "acceptable" categories therefore they match L1 sounds better than oː/ and / ɐː/ which are the example of "deviant" categories. However, in case of the contrast /iː/ - /ɪ/, the tense member is "acceptable" and lax /ɪ/ is "deviant". Following Best, the discrimination between the members of those contrasts was predicted to be from "moderate" to "very good", depending on the scale of perceived difference between L2 segments. This could be illustrated by the study since the overall scores for the test by the language group varied from 52.72% (the overall score for the contrast /ɐː/ - /ɐ/ by Spanish group) to 69.97% (the overall score for the contrast /oː/ - /ɔ/ by the Polish participants). Also, looking at the overall score for each contrast by language group, it can be concluded that the more different the members of the lax-tense contrast were, the more appropriately they were discriminated by L2 perceivers. The contrast /oː/ - /ɔ/ that had the all three phonetic differences was perceived most correctly by the participants, then the contrast /iː/ - /ɪ/ with 2 phonetic differences was perceived less correctly, and lastly the contrast /ɐː/ - /ɐ/ with 1 phonetic difference was perceived the least correctly. All the language groups had the highest score for the discrimination between the members of the contrast /oː/ - /ɔ/ (Polish 69.97%, Italian 66.27%, and Spanish 67.28%, then for /iː/ - /ɪ/ (Polish 65.17%, Italian 60.33%, Spanish 54.67%) and the lowest for /ɐː/ - /ɐ/ (Polish 63.33%, Italian 54.83%. Spanish 52.72%)

However, it must be noted that those scores correlated differently when analysed by different particular tests. For example, in the first test in which the participants listened to two words differentiating only in the contrasting vowels, the Polish and Italian informants discriminated between the members of the contrast just with one phonetic difference in length more appropriately than between those with two differences in length and tenseness (Polish /ɐ/- /ɐː/ - 70.66% and /ɪ/ - /iː/ - 70.33%, Italian /ɐ/- /ɐː/ - 72.66% and /ɪ/ - /iː/ - 70.66%). This suggests that those participants did not cumulate the available phonetic cues and relied more on the durational than the spectral cue. Such L2 perception pattern is contrary to the L1 perception since it has been demonstrated that native speakers of English rely more on the spectral information about the vowel rather than on the durational one (Hillenbrand, 2013:26). Similar L2 perception patterns were observed by Kondaurova & Francis (2008) in their study of L1 Spanish and Russian speakers who relied primarily or even in some cases only on length when identifying vowels from a tense - lax contrast. Escudero and

Boersma (2004) explain that phenomena by applying the L1 mechanism for acquiring optimal perception and detecting the duration differences which are absent in L1 in contrast to the spectral ones. Moreover, Bohn (1995) accounts for that with his desensitization hypothesis according to which the duration distinction is used when spectral properties are difficult to perceive. This correlates with the first research question on whether the participants relied more on spectral or durational properties when identifying a vowel.

However, it must be noted that the Spanish informants in the first test present a different pattern of L2 vowel perception to the Polish and Italian participants. The Spanish speakers cumulated the phonetic cues and they discriminated best between the members the contrast /oː/ - /ɔ/ (88.66%), then for /iː/ - /ɪ/ (75.66%) and lastly for /ɐː/ - /ɐ/ (72.66). Contrary to the other participants, they did not rely primarily on the durational cue when identifying the tested vowels. However, in the second test, they discriminated between the members of the second contrast less appropriately than between the members of the third one, therefore in this case relying more on the length properties of the tested sounds. The Polish and Italian respondents in the second test discriminated better between the members of the contrast /iː/ - /ɪ/ (Polish - 60,17%, Italian – 45.33%) than between /ɐː/ - /ɐ/ (Polish 53.33%, Italian – 45.33%).Also, it must be noted that that Italian participants discriminated between the members of /iː/ - /ɪ/ more appropriately than between the members of /oː/ - /ɔ/ which have the biggest spectral differences. Moreover, the Polish respondents in the second test had the biggest difficulties with that contrast. This suggests that even though there can be a significant difference between the members of the contrast (as in case of /oː/ and /ɔ/ in a height), it is still difficult for L2 perceivers to detect it.

In the third test which involved the participants to match the tested vowel with its orthographic representation, the Polish speakers discriminated between the members of the contrast /ʊː/ - /ʊ/ the most appropriately (66%), than /iː/ - /ɪ/ (65%) and /oː/ - /ɔ/ (63.5%). This again illustrates the scenario in which the informants did not cumulate the phonetic cues and relied on the duration the most. In case of Italian and Spanish informants, however, the phonetic cues were cumulated, and contrasts with the higher number of phonetic differences were discriminated better than those with a lower one.

The participants exhibit different strategies for L2 perception since in some case they relied more on durational cues rather than spectral and in some cases they cumulate the phonetic cues and do not rely primarily on the length. It must be noted that no stable pattern for the discrimination of the tested contrasts was observed. When analysed by language groups, as described above, in every

test the participants apply different strategies for discrimination between the tested contrasts. Escudero (2005) explains that at the start state of L2 phonology development, the L2 perceptual system is dynamic and not the same as the optimal perception of the particular language, however at the end state it is predicted by Escudero to stabilize (Escudero, 2005:95). Following Escudero (2005), participants acquiring English phonology were facing *new scenario* learning since they perceive fewer categories than L2 language produces (at least at the initial state of L2 phonology acquisition). The participants' L1 perception grammar contains fewer categories and this is why the members of the contrast might be perceived as one L1 sound. As Escudero explains, the informants here must recognize new sounds as distinct phonemes first and then create their representation in the lexicon. According to L2LP, the new scenario is the most difficult of all the three scenarios (described in 2.3.2), since it requires a learner not only to create new categories and their perceptual mapping but also to integrate those new dimensions with already- categorized dimensions. This prediction can be confirmed by the example of the informants of the longest time of residence who still struggled to discriminate between the members of the tested lax-tense contrasts.

Also comparing the scores of each test, it can be concluded that the informants have the least difficulties in discriminating between the members of the tested lax-tense contrasts when listening to them (Part I), since the scores for this test where the highest for each language group. More challenging was to match the tested vowel with its orthography and to discriminate between the written representations of the tested sound and its counterpart of the contrast (Part III).However, the informants had the biggest difficulties with matching the vowels with the pictures that sound representation included the same sound (Part II). Here they also had to recall the representational information about the vowel from their lexicon and were not hinted either by the actual sounds or its orthographies as in other two tests. Since, the average score by the language groups are the lowest in this test and some of them are as low as 35.33% (the Italian speakers for the contrast /ɐ:/ - /ɐ/) and 35.34% (the Spanish informants for the contrast /i:/ - /ɪ/), it can be concluded that while the participants might be able to detect those auditory differences and differentiate between the sounds when heard, they might have not established for them their representational categories in the lexicon. In comparison, the average score for the discrimination between the members of the contrast/ɐ:/ - /ɐ/ by Italian participants is 72.66% and of /i:/ - /ɪ/ by Spanish is 75.66%. According to Flege (1995), if the separate categories for new sounds have not been established, the L2 speakers' production of those segments will be inaccurate.

The data suggests that time of residence does not have a great impact on the discrimination ability between the members of the contrasts. It must be noted that in most cases, the informants of

the longest time of residence (10 years onwards) performed better than those of the shortest time (less than one year). However, there cannot be found a consequent pattern confirming that with the time of residence the discrimination ability constantly increases. Thus in many cases, the informants from middle groups of time of residence had higher scores than those with the longer one. It can be concluded that while time contributes to the discrimination ability between the members of the tested contrasts, there must be other contributing factors which were not explored in this study.

Moreover, the data was also analysed according to two levels of education: University and Secondary level. The study revealed that higher education had a positive effect on the discrimination between the members from the lax-tense contrasts since the informants with the university degree always had higher scores than those with a secondary one.

6. Conclusions

The study was conducted in to order to investigate what the strategies are for discrimination between the members of lax-tense contrast by L2 speakers whose native phoneme inventory lacks this distinction. A group of 18 Poles, 17 Italian and 15 Spanish speakers residing permanently in Australia participated in the study. Three different language groups were assessed in order to examine whether all of the informants use the same strategies for vowel identification when discriminating between the members of the tested contrasts. Three different lax-tense contrasts /ɐ:/ - /ɐ/, /i:/ - /ɪ/, /o:/ - /ɔ/ were used. While between the vowels from the first contrast there was one phonetic difference, between those from the second one there were two, and lastly between the sounds from third contrast there were 3 phonetic differences. This was in order to investigate whether the contrasts with more phonetic differences are discriminated more appropriately than those with a fewer number. According to PAM (Best, 1995) and SLM's (Flege, 1995) predictions, the more different the non-native vowels are, the easier they are for L2 speakers to discriminate. This could be supported by the overall average score from the three tests for each language group since the Polish, Italian and Spanish informants had the highest score for the contrast with the biggest number of phonetic differences and the lowest one for one with the fewest. However, it must be noted that those scores correlated differently when analysed by particular tests and different contrasts were discriminated the most appropriately and the least appropriately by different speakers. For example in the first test that involved the informants listening to two utterances and recognizing them as different words, the Polish and Italian participants had the highest score for the contrast /o:/ - /ɔ/ (Polish 92.66%, Italian 94%), then for the contrast /ɐ:/ - /ɐ/ (Polish 70.66%, 72.66%) and lastly for the contrast /i:/ - /ɪ/ (Polish 70.33%, Italian 70.66%). The Spanish speakers, however discriminated best between the vowel contrasts involving the biggest number of differences and poorest between those involving the lowest number the least (/o:/ - /ɔ/ 88.66%, /i:/-/ɪ/ 75.66%, /ɐ:/ - /ɐ / 72.66%). Therefore while the Spanish speakers cumulated all the phonetic cues the most in a native-like way, the Polish and Italian relied more on durational cue than the spectral (since the contrast differing only in duration was better discriminated than one differing in both duration and lax-tenseness).

Moreover, different contrasts were discriminated differently in Part II, in which the participants had to match the tested vowel with the picture/pictures that sound representation included the same sound. The Polish informants discriminated best between the members from the contrast /i:/-/ɪ/ (60.17%), then between /ɐ:/ - /ɐ / (53.33%) and lastly between the members of the contrast /o:/ - /ɔ/ (52.84%). Therefore, the contrast with the highest number of the phonetic

differences was perceived least well by the Polish speakers in this Part II. This suggests that even though there is a significant difference in height between those two vowels it is still challenging to the L2 perceiver to detect. It must be noted, however, that the difference in the score between this contrast and /oː/ - /ɔ/ is very small. In Part II, the Italian participants also discriminated best between /iː/ and /ɪ/ , however they had higher score for /oː/ - /ɔ/ (38.33%) and then lastly for /ɐː/ - /ɐ/ (35.33%). The Spanish informants, on the other hand perceived the contrast /oː/ - /ɔ/ (43.17) best, then /ɐː/ - /ɐ/ (36.50%) and lastly /iː/ - /ɪ/ (35.34%). It must be noted that again, the difference in score between the two last contrasts is very small.

In Part III, in the third test that involved the participants matching the tested vowel with their orthography, all Italian and Spanish informants displayed the same discrimination pattern. Here the contrast with three phonetic differences was matched the most appropriately (/oː/ - /ɔ/: Italian (66.5)%, Spanish 70%), one with 2 – less (/iː/ - /ɪ/: Italian 65%, Spanish 53%), while the contrast with one phonetic difference was most poorly matched (/ɐː/ - /ɐ/: Italian:56.5%, Spanish: 49%). The Polish speakers, however had the highest score for the contrast with the fewest number of phonetic differences and the lowest for one with the biggest number (/ɐː/ - /ɐ/ 66%, /iː/ - /ɪ/ 65%, /oː/ - /ɔ/ 63.5%).

As presented above, the participants applied different strategies for different tests , pointing to the fact that their L2 perception system is still dynamic. No regular pattern for any of the language groups can be found. While in some cases, they cumulate the phonetic cues, in others they ignore them and focus more on the duration. The time of residence does not seem to have a great impact on the discrimination ability since there are cases in which the informants with the shorter time of residence have the higher score than those with the longer time. The level of education has a positive effect, however, since the participants with the university degree outperformed those with the secondary. However, since the time of residence did not play as significant a factor as expected, this suggests that there must be other essential factors that contribute to that phenomenon but which were not explored by this study.

References:

Best,C. T. (1994). The emergence of native-language phonological influences in infants: A perceptual assimilation model. *The Development of Speech Perception: The Transition from Speech Sounds to Spoken Words*, 167-224.

Best, C.T. (1995). A direct realist view of cross-language speech perception. In Strange, W. (ed.).*Speech Perception and Linguistic Experience: Theoretical and Methodological Issues*. Baltimore: York Press. pp. 171-203.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. *Language Experience in Second Language Speech Learning: In Honor of James Emil Flege, ,* 13-34.

Bohn, O., & Flege, J. E. (1992). The production of new and similar vowels by adult German learners of English. *Studies in Second Language Acquisition*, 14(2), 131-158.

Bohn, O. (1995). Cross language speech production in adults: First language transfer doesn't tell it all. In Strange, W. (ed.).*Speech Perception and Linguistic Experience: Theoretical and Methodological Issues*. Baltimore: York Press, pp. 279-304/

Bryła-Cruz, A. (2010).Native speakers' reactions to Polish-accented English - empirical evidence. In Proceedings of the 6th International Symposium on the Acquisition of Second Language Speech, New Sounds 2010, Poznań, Poland, 1-3 May 2010, pp. 55-60.

Escudero, Paola. 2005. *Linguistic perception and second language acquisition: Explaining the attainment of optimal phonological categorization*. University of Utrecht doctoral dissertation. Utrecht: LOT.

Escudero, P.,& Boresma. P. (2004). Bridging the gap between L2 speech perception research and phonological theory. *Stud.Second Lang. Acquis*.26,pp. 551-585.

Flege, J.E. (1995). Second language speech theory, findings and problems. In Strange, W (ed.).*Speech Perception and Linguistic Experience: Theoretical and Methodological Issues*. Baltimore: York Press. pp. 233-277.

Flege, J., Schirru, C., & MacKay, I. (2003). Interaction between the native and second

language phonetic subsystems. *Speech Communication*, 40, 467-491.

Gass,S.,M., & Selinker,L. (2008). *Second Language Acquisition: An Introductory Course.* New York, NY: Routledge.

Hillenbrand, J. M. (2013). Static and Dynamic Approaches to Vowel Perception. In Morrison, G.S. & Asssmann, P.F. (ed) *Vowel Inherent Spectral Change Modern Acoustics and Signal Processing*. Springer-Verlag, Berlin Heidelberg.

Jassem, W. Polish. *Illustration of the IPA.* Retrieved from: http://ifa.amu.edu.pl/~krynicki/teaching/cg/files/06_phonetics_JASSEM.pdf

Knutson, P. *Tense vowels*. Retrieved from: https://notendur.hi.is/peturk/KENNSLA/02/TOP/VowelsTense.html

Kondaurova, M.V & Francis, A.L. (2008). *The relationship between native allophonic experience with vowel duration and perception of the English tense/lax vowel contrast by Spanish and Russian listeners.* Incomplete reference

Kopečková, R. (2010). Learning Vowel Sounds in a Migrant Setting: The Case of Polish Children and Adults in Ireland. In *Proceedings of the 6th International Symposium on the Acquisition of Second Language Speech, New Sounds 2010*, Poznań, Poland, 1-3 May 2010, pp 257-262.

Iverson, P., & Kuhl, P.K. (1995). Linguistic Experience and "Perceptual Magnet Effect". In Strange, W (ed.).*Speech Perception and Linguistic Experience: Theoretical and Methodological Issues.* Baltimore: York Press. pp. 233-277.

Puppel, S. (1990). Some preliminary observations on Polish and English vowels spaces in contact. In Fisiak, J (ed). *Further Insights into Contrastive Analysis*. John Benjamins Publishing Company. pp. 241-253.

Repp, B. H. (1984). Categorical Perception: Issues, Methods, Findings. In Lass, N. (ed.). 1984. *Speech and Language. Advances in Basic Research and Practice*. Volume 10. pp. 243-335.

Rojczyk, A. (2010). Production and perception of vowel /æ/ by Polish learners of English. In Proceedings of the 6th International Symposium on the Acquisition of Second Language Speech, *New Sounds 2010*, Poznań, Poland, 1-3 May 2010, pp. 386-391.

Rogers, D., & d'Arcangeli, L. (2004). Illustrations of the IPA: Italian, *Journal of the International Phonetic Association*, 34(1), 117-121.

Salcedo,C.,S. (2010). *The Phonological System of Spanish.* Retrieved from: http://connection.ebscohost.com/c/articles/78554745/phonological-system-spanish

Smiljanic, R. (2011) http://utsoundlab.files.wordpress.com/2012/04/lp-handbook_ch-16.pdf

Strange, W. (1995). Cross-language studies of speech perception: A historical review. *Speech Perception and Linguistic Experience: Issues in Cross-language Research.* Timonium, MD: York Press.

Werker, J.F., & Tees, R.C. (1984). *Cross-Language Speech Perception: Evidence for Perceptual Reorganization during the First Year of Life*. Retrieved from:

http://www.cs.indiana.edu/~port/teach/641/Werker.Tees.crosslg.sp.perceptn.1984.pdf

Appendices

These appendices include detailed material which is summarized in the body of this thesis. Appendix A shows the results for recognizing word-pairs varying only in the research vowels either as the "same" or "different" word in each level of difficulty. Appendix B shows the separate results for matching each member of the tested contrast with the right picture/pictures in each type of question. Finally, Appendix C shows the separate results for matching each member of the tested contrast with the right orthography.

Appendix A (Part I)

Level:	First level			Second level			Third level		
Time of R.	P.	I.	S.	P.	I.	S.	P.	I.	S.
< 1y	100%	100%	60%	25%	50%	60%	50%	50%	80%
1-2y	100%	100%	100%	100%	75%	100%	50%	75%	50%
2-4y	80%	100%	100%	80%	100%	100%	60%	50%	100%
4-8y	100%	0%	100%	100%	100%	67%	50%	100%	0%
+10y	80%	75%	100%	60%	75%	0%	60%	50%	100%
Total by L:	89%	88%	87%	67%	71%	73%	56%	59%	60%
Total:	88%			70%			58%		

Table A1. The discrimination of /ɐ:/ and /ɐ/ in three levels by Polish, Italian and Spanish speakers by time of residence.

Level:	First level			Second level			Third level		
Time of R.	P.	I.	S.	P.	I.	S.	P.	I.	S.
< 1y	100%	83%	100%	50%	67%	40%	100%	50%	60%
1-2y	100%	100%	100%	100%	75%	100%	50%	50%	75%
2-4y	60%	100%	50%	100%	100%	100%	60%	50%	50%
4-8y	100%	100%	67%	100%	0%	67%	50%	100%	67%
+10y	40%	75%	100%	20%	50%	100%	60%	75%	100%
Total by L:	72%	88%	87%	78%	65%	73%	61%	59%	67%
Total:	82%			72%			62%		

Table A2. The discrimination of /i:/ and /ɪ/ in three levels by Polish, Italian and Spanish speakers by time of residence.

Level:	First level			Second level			Third level		
Time of R.	P.	I.	S.	P.	I.	S.	P.	I.	S.
< 1y	100%	100%	80%	75%	83%	20%	100%	100%	100%
1-2y	100%	100%	100%	100%	100%	100%	100%	100%	100%
2-4y	100%	100%	100%	80%	50%	100%	100%	100%	100%
4-8y	100%	100%	100%	50%	100%	100%	100%	100%	100%
+10y	100%	100%	100%	80%	75%	100%	100%	100%	100%
Total by L:	100%	100%	93%	78%	82%	73%	100%	100%	100%
Total:	98%			74%			100%		

Table A3. The discrimination of /o:/ and /ɔ/ in three levels by Polish, Italian and Spanish speakers by time of residence.

Appendix B (Part II)

Q26: /ɐ:/ in /fɐ:/	Polish			Italian			Spanish		
Time of R.	**/kɐ:d/ "card"**	**/dɐk/ "duck"**	**both**	**/kɐ:d/ "card"**	**/dɐk/ "duck"**	**both**	**/kɐ:d/ "card"**	**/dɐk/ "duck"**	**both**
< 1y	25%	75%	-	17%	-	83%	60%	20	20%
1 - 2y	-	100%	-	50%	-	50%	50%	-	50%
2 - 4y	80%	20%	-	50%	-	50%	100%	-	-
4 - 8y	50%	-	50%	-	-	100%	67%	-	33%
+ 10y	60%	20%	20%	100%	-	-	0%	100	0%
Total by L:	50%	39%	11%	47%	-	53%	60%	13%	27%
Total:	**/kɐ:d/ "card"**			**/dɐk/ "duck"**			**both**		
	53%			17%			30%		

Table A4. Matching /ɐ:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question).

Q 36: /ɐ/ in /nɐts/	Polish			Italian			Spanish		
Time of R.	**/bɐs/ "bus"**	**/kɐ:/ "car"**	**both**	**/bɐs/ "bus"**	**/kɐ:/ "car"**	**both**	**/bɐs/ "bus"**	**/kɐ:/ "car"**	**both**
< 1y	75%	25%	-	17%	17%	66%	20%	20%	80%
1 - 2y	100%	-	-	100%	-	-	25%	-	75%
2 - 4 y	60%	-	40%	100%	-	-	100%	-	-
4 - 8 y	100%	-	-	100%	-	-	100%	-	-
+ 10y	60%	20%	20%	75%	25%	-	100%	-	-
Total by L:	72%	11%	17%	64%	12%	24%	60%	17%	33%
Total:	**/bɐs/ "bus"**			**/kɐ:/ "car"**			**Both**		
	65%			13%			25%		

Table A5. Matching /ɐ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question)

Q23: /i:/ in /li:v/	Polish			Italian			Spanish		
Time of R.	**/fi:t/ "feet"**	**/fɪŋgə / "finger"**	**both**	**/fi:t/ "feet"**	**. fɪŋgə / "finger"**	**both.**	**/fi:t/ "feet"**	**/fɪŋgə / "finger"**	**both**
< 1y	50%	-	50%	33%	-	66%	60%	-	40%
1-2y	50%	-	50%	50%	-	50%	75%	-	25%
2-4y	40%	-	60%	50%	-	50%	100%	-	-
4-8y	50%	50%	-	100%	-	-	66%	-	33%
+10y	100%	-	-	100%	-	-	100%	-	-
Total by L:	72%	6%	33%	59%	0%	41%	73%	0%	27%
Total:	**/fi:t/ "feet"**			**/fɪŋgə / "finger"**			**both**		
	68%			2%			33%		

Table A6. Matching /i:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question).

Q38: /ɪ/ in /lɪv/	Polish			Italian			Spanish		
Time of R.	**/pɪg/ "pig"**	**/bi:/ "bee"**	**both**	**/pɪg/ "pig"**	**/bi:/ "bee"**	**both**	**/pɪg/ "pig"**	**/bi:/ "bee"**	**both**
< 1y	50%	25%	25%	33%	17%	50%	20%	40%	40%
1-2y	50%	50%	-	25%	25%	50%	50%	-	50%
2-4 y	20%	60%	20%		100%		-	100%	-
4-8 y	100%	-	-	100%	-	-	67%	-	33%
+10y	80%	20	-	25%	75%	-	-	100%	
Total by L:	56%	33%	11%	29%	41%	29%	33%	33%	33%
Total:	**/pɪg/ "pig"**			**/bi:/ "bee"**			**both**		
	40%			36%			24%		

Table A7. Matching /ɪ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question).

Q 33: /o:/ in /ho:s/	Polish			Italian			Spanish		
Time of R.	**ko:n corn**	**kɔfi: coffee**	**both**	**ko:n corn**	**kɔfi: coffee**	**both**	**ko:n corn**	**kɔfi: coffee**	**both**
< 1y	75%	-	25%	50%	-	50%	80%	20%	-
1 - 2y	100%	-	-	25%	25%	50%	75%	-	25%
2 - 4y	40%	40%	20%	50%	-	50%	100%	-	-
4 - 8y	100%	-	-	-	100%	-	33%	33%	33%
+ 10y	60%	40%	-	75%	-	25%	100%	-	-
Total by L:	67%	22%	11%	47%	12%	41%	73%	13%	13%
Total:	**ko:n corn**			**kɔfi: coffee**			**both**		
	62%			16%			22%		

Table A8. Matching /o:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question).

Q 44: /ɔ/ in /gɔt/	Polish			Italian			Spanish		
Time of R.	**dɔg dog**	**do: door**	**both**	**dɔg dog**	**do: door**	**both**	**dɔg dog**	**do: door**	**both**
< 1y	50%	-	50%	50%	-	50%	40%	-	60%
1 - 2y	50%	-	50%	75%	-	25%	25%	-	75%
2 - 4 y	60%	20%	20%	100%	-	-	50%		50%
4 - 8 y	100%	-	-	100%	-	-	33%		67%
+ 10y	60%	-	40%	75%	-	25%	-	100%	-
Total by L:	61%	5%	33%	71%	-	29%	33%	7%	60%
Total:	**dɔg dog**			**do: door**			**both**		
	56%			4%			20%		

Table A9. Matching /ɔ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (2nd type of question).

Q 29: /e:/ in /e:m/	Polish					Italian					Spanish				
Time of R.	ɐ:	ɐ	ɐ: & ɐ	ɐ & ɐ	ɐ: & ɐ & ɐ	ɐ:	ɐ	ɐ: & ɐ	ɐ & ɐ	ɐ: & ɐ & ɐ	ɐ:	ɐ	ɐ: & ɐ	ɐ & ɐ	ɐ: & ɐ & ɐ
< 1y	75%	-	-	25% %	-	-	17%	33%	-	50%	-	80%	20%	-	-
1 - 2y	50%	-	-	50%	-	50%	25%	25%	-	-	25%	50%	-	-	25%
2 - 4y	20%	-	40%	20%	20%	-	50%	-	50%	-	50%	50%	-		-
4 - 8y	50%	-	50%	-	-	-	-	-	-	100 %	-	100	-	-	-
+ 10y	60%	-	20%	-	20%	25%	50%	-	25%	-	-	-	100 %		-
Total by L:	50%	-	22%	17%	11%	18%	29%	18%	12%	24%	13%	67%	13%		7%
Total:	ɐ:			ɐ		ɐ: & ɐ			ɐ & ɐ		ɐ: & ɐ & ɐ				
	28%			30%		18%			10%		14%				

Table A10. Matching /ɐ:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

Q 24: /e/ in /trek/	Polish					Italian					Spanish				
Time of R.	ɐ	ɐ:	ɐ & ɐ:	2 x ɐ:	ɐ & 2 x ɐ:	ɐ	ɐ:	ɐ & ɐ:	2 x ɐ:	ɐ & 2 x ɐ:	ɐ	ɐ:	ɐ & ɐ:	2 x ɐ:	ɐ & 2 x ɐ:
< 1y	50%	25%	25%	-	-	-	-	17%	33%	50%	40%	20%	-	40%	-
1 - 2y	-	100 %	-	-	-	50%	-	-	50%	-	25%	-	-	50%	25%
2 - 4y	40%	20%	-	-	40%	-	50%	-	50%	-	100 %	-	-	-	-
4 - 8y	-	-	50%	-	50%	-	-	-	100 %	-	-	33%	33%	-	33%
+ 10y	20%	-	40%	-	40%	75%	25%	-	-	-	-	100 %	-	-	
Total by L:	28%	22%	22%	-	28%	29%	12%	6%	35%	18%	33%	20%	7%	27%	13%
Total:	ɐ			ɐ:		ɐ & ɐ:			2 x ɐ:		ɐ & 2 x ɐ:				
	30%			18%		12%			20%		20%				

Table A11. Matching /ɐ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

Q 40: /i:/ in /fi:d/	Polish					Italian					Spanish				
Time of R.	**i:**	**ɪ**	**i: & ɪ**	**ɪ & ɪ**	**i: & ɪ & ɪ**	**i:**	**ɪ**	**i: & ɪ**	**ɪ & ɪ**	**i: & ɪ & ɪ**	**i:**	**ɪ**	**i: & ɪ**	**ɪ & ɪ**	**i: & ɪ & ɪ**
< 1y	50%	-	50%	-	-	83%	-	17%	-	-	60%	20%	20%	-	-
1 - 2y	100 %	-	-	-	-	50%	-	50%	-	-	50%	50%	-	-	-
2 - 4y	60%	20%	20%	-	-	100 %	-	-	-	-	100 %	-	-	-	-
4 - 8y	100 %	-	-	-	-	-	-	100 %	-	-	33%	33%	33%	-	-
+ 10y	80%	20%	-	-	-	50%	25%	25%	-	-	-	-	100 %	-	-
Total by L:	72%	11%	17%	-	-	65%	6%	29%	-	-	53%	27%	20%	-	-
Total :	**i:**			**ɪ**		**i: & ɪ**			**ɪ & ɪ**		**i: & ɪ & ɪ**				
	64%			14%		22%			-		-				

Table A12. Matching /i:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

.

Q 43: /ɪ/ in /θɪk	Polish					Italian					Spanish				
Time of R.	**ɪ**	**i:**	**ɪ & i:**	**2 x i:**	**ɪ & 2 x i:**	**ɪ**	**i:**	**ɪ & i:**	**2 x i:**	**ɪ & 2 x i:**	**ɪ**	**i:**	**ɪ & i:**	**2 x i:**	**ɪ & 2 x i:**
< 1y	25%	25%	-	-	50%	50%	-	50%	-	-	40%	-	40%	-	20%
1 - 2y	50%	-	-	50%	-	75%	-	25%	-	-	25%	25%	25%	-	25%
2 - 4y	20%	-	80%	-	-	50%	50%	-	-	-	50%	50%	-	-	-
4 - 8y	100 %	-	-	-	-	100 %	-	-	-	-	33%	-	66%	-	-
+ 10y	80%	-	20%	-		100 %	-	-	-	-	-	-	100 %	-	-
Total :	50%	6%	28%	6%	11%	71%	6%	24%	-	-	33%	13%	40%	-	13%
Total :	**ɪ**			**i:**		**ɪ & i:**			**2 x i:**		**ɪ & 2 x i:**				
	52%			8%		30%			2%-		8%				

Table A13. Matching /ɪ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

.

Q 28: /o:/ in /ko:l/	**Polish**					**Italian**					**Spanish**				
Time of R.	**o:**	**ɔ**	**o: & ɔ**	**ɔ & ɔ**	**All**	**o:**	**ɔ**	**o: & ɔ**	**ɔ & ɔ**	**All**	**o:**	**ɔ**	**o: & ɔ**	**ɔ & ɔ**	**All**
< 1y	50%	-	25%	-	25%	50%	-	50%	-	-	100 %	-	-	-	-
1 - 2y	50%	-	-	50%	-	25%	25%	25%	-	25%	50%	-	50%	-	-
2 - 4y	20%	-	20%	20%	40%	50%	-	50%	-	-	50%	-	-	50%	-
4 - 8y	-	50%	50%	-	-	-	-	100 %	-	-	67%	-	33%	-	-
+ 10y	60%	-	40%	-	-	50%	50%	-	-	-	1/1 100 %	-	-	-	-
Total:	39%	6%	28%	11%	17%	41%	18%	35%	-	6%	73%	-	30%	7%	
Total:	**o:**			**ɔ**		**o: & ɔ**			**ɔ & ɔ**		**All**				
	50%			8%		28%			6%		8%-				

Table A14. Matching /o:/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

Q 46: /ɔ/ in /sɔk/	**Polish**					**Italian**					**Spanish**				
Time of R.	**ɔ**	**o:**	**ɔ& o:**	**2 x o:**	**All**	**ɔ**	**o:**	**ɔ& o:**	**2 x o:**	**All**	**ɔ**	**o:**	**ɔ& o:**	**2 x o:**	**All**
< 1y	25%	-	50%	-	25%	33%	-	33%	-	33%	40%	20%	20%	-	20%
1 - 2y	100 %	-	-	-	-	-	25%	50%	-	25%	25%	-	75%	-	-
2 - 4y	40%	20%	40%	-	-	-	-	100 %	-	-	100 %	-	-	-	-
4 - 8y	50%	-	50%	-	-			100 %	-	-	33%	-	-	-	66%
+ 10y	40%	-	60%	-	-	50%	50%	-	-	-	-	-	100 %	-	-
Total:	44%	6%	44%		6%	4/17 24%	18%	42%		18%	40%	7%	33%	-	20%
Total:	**ɔ**			**o:**		**ɔ& o:**			**2 x o:**		**All**				
	36%			10%		40%			-		14%				

Table A15. Matching /ɔ/ to the image that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (3rd type of question).

Q 42: /e:/ in /fe:m/	Polish					Italian					Spanish				
Time of R.	**ɐ: & ɐ:**	**ɐ:**	**ɐ**	**ɐ: & ɐ**	**All**	**ɐ: & ɐ:**	**ɐ:**	**ɐ**	**ɐ: & ɐ**	**All**	**ɐ: & ɐ:**	**ɐ:**	**ɐ**	**ɐ: & ɐ**	**All**
< 1y	75%	25%	-	-	-	33%	67%	-	-	-	20%	20%	-	60%	-
1 - 2y	-	100 %	-	-	-	50%	25%	-	25%	-	50%	25%	-	25%	
2 - 4y	60%	20%	-	-	20%	-	100 %	-	-	-	50%	50%	-	-	-
4 - 8y	100 %	-	-	-	-	100 %	-	-	-	-	33%		33%	33%	-
+ 10y	80%	-	-	20%	-		75%	-	25%	-	-	100 %	-	-	-
Total:	67 %	22 %	-	6%	6%	30 %	59 %	-	12 %	-	33 %	27 %	7%	33 %	-
Total:	**ɐ: & ɐ:**			**ɐ:**		**ɐ**			**ɐ: & ɐ**		**All**				
	44%			36%		2%			16%		2%				

Table A16. Matching /ɐ:/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Q 41: /e/in /kɐp/	Polish					Italian					Spanish				
Time of R.	**/ɐ/ & /ɐ/**	**/ɐ/**	**/ɐ:/**	**/ɐ/ & /ɐ:/**	**All**	**/ɐ/ & /ɐ/**	**/ɐ/**	**/ɐ:/**	**/ɐ/ & /ɐ:/**	**All**	**/ɐ/ & /ɐ/**	**/ɐ/**	**/ɐ:/**	**/ɐ/ & /ɐ:/**	**All**
< 1y	75%	25%	-	-	-	33%	-	17%	-	50%	-	-	60%	40%	-
1 - 2y	50%	-	-	50%	-	25%	25%	-	25%	25%	-	50%	25%	-	25%
2 - 4y	60%	-	40%	-	-	50%	-	50%	-	-	50%	-	-	50%	-
4 - 8y	50%	-	50%	-	-	-	-	-	-	100 %	33%	-	33%	33%	-
+ 10y	20%	20%	-	20%	40%	-	25%	75%	-	-	100 %	-		-	-
Total by L:	50%	11%	17%	11%	11%	24%	12%	29%	6%	29%	20%	13%	33%	27%	7%
Total:	**/ɐ/ & /ɐ/**			**/ɐ/**		**/ɐ:/**			**/ɐ/ & /ɐ:/**		**All**				
	32%			12%		26%			14%		16%				

Table A17. Matching /ɐ/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Q 30: /i:/ in /fi:t/	Polish					Italian					Spanish				
Time of R.	**i: & i:**	**i:**	**ɪ**	**i: & ɪ**	**All**	**i: & i:**	**i:**	**ɪ**	**i: & ɪ**	**All**	**i: & i:**	**i:**	**ɪ**	**i: & ɪ**	**All**
< 1y	25%	25 %	50%	-	-		67%		17%	17%	20%	60%	-	20%	-
1 - 2y	50%	50 %	-	-	-	50%	-	50%	-	-	-	50%	-	-	50%
2 - 4y	40%	20 %	20%	-	20%	50%	50%	-	-	-	-	100 %	-	-	-
4 - 8y	100 %	-	-	-	-	-	100 %	-	-	-	33%	66%	-	-	-
+ 10y	100 %	-	-	-	-	25%	75%	-	-	-	100 %	-	-	-	-
Total:	61 %	17 %	17 %	-	6%	24 %	53 %	12 %	6%	6%	20 %	60 %	-	7%	13 %
Total:	**i: & i:**			**i:**		**ɪ**			**i: & ɪ**		**All**				
	36%			42%		10%			4%		8%				

Table A18. Matching /i:/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Q 45: /ɪ/ in /bɪt/	Polish					Italian					Spanish				
Time of R.	**ɪ & ɪ**	**ɪ**	**i:**	**ɪ & i:**	**All**	**ɪ & ɪ**	**ɪ**	**i:**	**ɪ & i:**	**All**	**ɪ & ɪ**	**ɪ**	**i:**	**ɪ & i:**	**All**
< 1y	25%	25%	-	50%	-	33%	17%	17%	33%	-	-	20%	40%	20%	20%
1 - 2y	-	100 %	-	-	-	25%	-	25%	-	50%	-	50%	25%	25%	
2 - 4y	-	20%	-	60%	20%	50%	50%	-	-	-	-	50%	50%		
4 - 8y	50%	-	50%	-	-	100 %	-	-	-	-	-	33%	-	33%	33%
+ 10y	60%	-	20%	-	20%	25%	-	50%	25%	-	-	-	100 %		
Total:	50%	11%	17%	11%	11%	24%	12%	29%	6%	29%	0%	33%	33%	27%	7%
Total:	**ɪ & ɪ**			**ɪ**		**i:**			**ɪ & i:**		**All**				
	26%			18%		26%			14%		16%				

Table A19. Matching /ɪ/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Q 31: /o:/ in /fo:t/	Polish					Italian					Spanish				
Time of R.	**o: & o:**	**o:**	**ɔ**	**o: & ɔ**	**All**	**o: & o:**	**o:**	**ɔ**	**o: & ɔ**	**All**	**o: & o:**	**o:**	**ɔ**	**o: & ɔ**	**All**
< 1y	50%	25%	-	-	25%	33%	33%	17%	-	17%	-	40%	-	40%	20%
1 - 2y	50%	50%	-	-	-	-	50%	-	-	50%	-	50%	-	-	50%
2 - 4y	60%	-	-	-	40%	-	50%	50%	-	-	50%	-	-	50%	-
4 - 8y	50%	-	-	50%	-	-	100 %	-	-	-	-	-	67%	-	33%
+ 10y	40%	20%	-	-	40%	-	50%	50%	-	-	-	100 %	-	-	-
Total by L:	50%	17%	-	6%	28%	12%	47%	29%	-	12%	7%	33%	13%	20%	27%
Total:	**o: & o:**			**o:**		**ɔ**			**o: & ɔ**		**All**				
	24%			32%		14%			8%		22%				

Table A20. Matching /ɔ/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Q 35: /ɔ/ in /tɔt/	Polish					Italian					Spanish				
Time of R.	**ɔ & ɔ**	**ɔ**	**o:**	**ɔ & o:**	**All**	**ɔ & ɔ**	**ɔ**	**o:**	**ɔ & o:**	**All**	**ɔ & ɔ**	**ɔ**	**o:**	**ɔ & o:**	**All**
< 1y	25%	50%	25%	-	-	50%	-	-	-	50%	80%	-	20%	-	-
1 - 2y	50%	50%	-	-	-	25%	25%	-	-	50%	-	50%	-	-	50%
2 - 4y	60%	20%	-	-	20%	50%	50%	-	-	-	50%	50%	-	-	-
4 - 8y	100 %	-	-	-	-	-	-	-	-	100 %	-	33%	-	33%	33%
+ 10y	60%	20%	-	20%	-	25%	50%	-	-	25%	-	100 %	-	-	-
Total by L:	56%	28%	6%	6%	6%	35%	24%	-	-	41%	33%	33%	7%	7%	20%
Total:	**ɔ & ɔ**			**ɔ**		**o:**			**ɔ & o:**		**All**				
	42%			28%		4%			4%		22%				

Table A21. Matching /ɔ/ to the images that sound representation included either the right member of the contrast, its counterpart or both of them by time of residence (4th type of question).

Appendix C (Part III)

/ɐ:/	Polish							Italian							Spanish						
Time of R.	**ɐ:**	**ɐ**	**æ**	**ɐ: &ɐ**	**ɐ: &æ**	**ɐ &æ**	**All**	**ɐ:**	**ɐ**	**æ**	**ɐ: &ɐ**	**ɐ: &æ**	**ɐ &æ**	**All**	**ɐ:**	**ɐ**	**æ**	**ɐ: &ɐ**	**ɐ: &æ**	**ɐ &æ**	**All**
< 1y	58 %	8%	17 %	17 %	-	-	-	72 %	17%	-	11 %	-	-	-	27 %	47 %	13%	8 %	8 %	-	-
1-2y	67 %	17 %	-	-	-	-	17 %	50 %	17%	17 %	17 %	-	-	-	75 %	17 %	8%	-	-	8 %	-
2-4y	60 %	20 %	-	-	-	20 %	-	33 %	33%	17 %	-	-	17%	-	67 %	33 %	-	-	-	-	-
4-8y	75 %	33 %	-	-	-	-	-	100%	-	-	-	-	-	-	56 %	11 %	11%	-	11 %	11 %	-
+10y	67 %	27 %	7 %	-	-	-	-	50 %	25%	17 %	-	8 %	-	-	33 %	67 %	-	-	-	-	-
Total by L:	63 %	20 %	6 %	4 %	-	6 %	2 %	59 %	20%	10 %	8 %	2 %	1%	--	49 %	31 %	9%	2 %	4 %	4 %	-

Total:	ɐ:	ɐ	æ	ɐ: &ɐ	ɐ: &æ	ɐ &æ	All
	57%	23%	8%	5%	2%	4%	1%

Table A22. Matching /ɐ:/ to the right or wrong orthographies by time of residence.

/ɐ/	Polish							Italian							Spanish						
Time of R.	**ɐ**	**ɐ:**	**æ**	**ɐ &ɐ:**	**ɐ &æ**	**ɐ: &æ**	**All**	**ɐ**	**ɐ:**	**æ**	**ɐ &ɐ:**	**ɐ &æ**	**ɐ: &æ**	**All**	**ɐ**	**ɐ:**	**æ**	**ɐ &ɐ:**	**ɐ &æ**	**ɐ: &æ**	**All**
< 1y	58 %	-	8 %	-	25 %	8 %	-	39 %	6%	6 %	11 %	22 %	6%	11 %	40 %	13 %	27%	-	20 %	-	-
1-2y	67 %	-	17 %	-	17 %	-	-	58 %	-	25 %	-	8 %	8%	-	33 %	17 %	33%	-	17 %		-
2-4y	40 %	13 %	7 %	-	13 %	-	-	50 %	17%	33 %	-	-		-	67 %	17 %	17%	-	-	-	-
4-8y	83 %	-	-	-	17 %	-	-	100%	-	-	-	-	-	-	67 %	-	11%	-	22 %		-
+10y	73 %	13 %	13 %	-	-	-	-	75 %	8%	8 %	8 %	8 %	-	-	67 %	-	-	-	33 %	-	-
Total:	69 %	7%	9 %	-	13 %	2 %	-	54 %	6%	14 %	6 %	10 %	4%	4 %	49 %	11 %	22%	-	18 %		-

Total:	ɐ	ɐ:	æ	ɐ &ɐ:	ɐ &æ	ɐ: & æ	All
	58%	8%	15%	2%	13%	2%	1%

Table A23. Matching /ɐ/ to the right or wrong orthographies by time of residence.

/i:/	**Polish**			**Italian**			**Spanish**		
Time of R.	**i:**	**ɪ**	**both**	**i:**	**ɪ**	**both**	**i:**	**ɪ**	**both**
< 1y	83%	8%	8%	72%	17%	11%	53%	47%	-
1-2y	83%	17%	-	75%	25%	-	58%	42%	-
2-4y	33%	33%	33%	100%	-	-	33%	67%	-
4-8y	100%	-	-	100%	-	-	67%	33%	-
+10y	67%	27%	8%	67%	25%	8%	33%	67%	-
Total by L:	65%	20%	15%	65%	18%	18%	53%	47%	-
Total:	**i:**			**ɪ**			**both**		
	61%			29%			8%		

Table A24. Matching /i:/ to the right or wrong orthographies by time of residence.

ɪ	**Polish**			**Italian**			**Spanish**		
Time of R.	**ɪ**	**i:**	**both**	**ɪ**	**i:**	**both**	**ɪ**	**i:**	**both**
< 1y	75%	8%	17%	50%	17%	33%	53%	27%	20%
1-2y	67%	17%	17%	67%	25%	8%	67%	33%	-
2-4y	60%	20%	20%	67%	33%	-	50%	50%	-
4-8y	83%	17%	-	100%	-	-	33%	33%	33%
+10y	53%	33%	17%	75%	8%	17%	67%	33%	-
Total by L:	65%	20%	15%	65%	18%	18%	53%	33%	13%
Total:	**ɪ**			**i:**			**both**		
	61%			24%			15%		

Table A25. Matching /ɪ/ to the right or wrong orthographies by time of residence.

o:	Polish			Italian			Spanish		
Time of R.	o:	ɔ	both	o:	ɔ	both	o:	ɔ	both
< 1y	75%	25%	-	89%	6%	6%	87%	13%	-
1-2y	100%	-	-	83%	17%	-	58%	25%	17%
2-4y	73%	20%	7%	83%	17%	-	83%	17%	-
4-8y	100%	-	-	67%	33%	-	67%	33%	-
+10y	87%	7%	7%	75%	17%	8%	100%	-	-
Total:	83%	13%	4%	82%	14%	4%	76%	20%	4%
Total:	o:			ɔ			both		
	80%			15%			4%		

Table A26. Matching /o:/ to the right or wrong orthographies by time of residence.

ɔ	Polish			Italian			Spanish		
Time of R.	ɔ	o:	both	ɔ	o:	both	ɔ	o:	both
< 1y	25%	33%	42%	33%	56%	11%	67%	33%	-
1-2y	17%	50%	33%	33%	67%	-	67%	25%	8%
2-4y	60%	20%	20%	67%	33%	-	67%	33%	-
4-8y	67%	-	33%	100%	-	-	56%	44%	-
+10y	47%	47%	6%	75%	25%	-	67%	33%	-
Total:	44%	31%	24%	51%	45%	4%	64%	33%	2%
Total:	ɔ			o:			both		
	53%			37%			11%		

Table A27. Matching /ɔ/ to the right or wrong orthographies by time of residence.