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The Effect of Cross-language Phonetic Similarity Perception on Second Language Speech Learning: The Case of Polish Migrant Children and Adults in Ireland

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Declarations

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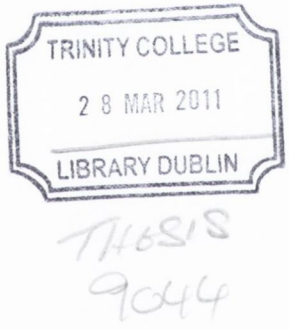

Summary

The main goal of this thesis was to gain a better understanding of age-related differences in second language speech learning. Specifically, it was of interest in the present study to explore whether child learners of a second language might be more accurate in their perception and production of non-native vowel sounds than adult learners, and whether this might be related to the way they perceive cross-language phonetic similarity. This reasoning draws on the central hypothesis of the most influential second language speech learning model at present, the Speech Learning Model (Flege, 1995), which, however, has not been tested extensively to date. The hypothesis is based on the assumption that children are commonly more successful learners of a second language because of the way their languages interact during second language acquisition. It claims that, since children's internal representations for native language sounds are still developing, such representations influence perception of non-native sounds less than in the case of adults. As a result, children are predicted to discriminate between the sounds of their native language and a second language more accurately, and eventually, to perceive and produce the second language sounds with more native-like ability.

To test this hypothesis, a group of 20 Polish children and 20 Polish adults, who had lived in Dublin for about three years at the time of the study, performed the following language tasks: 1) a cross-language assimilation task, to determine their perception of similarities between chosen native and non-native vowel sounds; 2) a categorical discrimination task, to determine their perception of non-native vowels; and 3) a delayed repetition task, to test their production of the non-native vowels. In addition, data on the participants' language learning histories, attitudes and contact with Polish and English were elicited by means of a detailed background questionnaire and a semi-structured interview. The participants' data were

compared to those elicited from a control group of 19 Polish children and adults who were learning English without any immersion experience, and 20 age-matched native speakers of Irish English.

The results of the study confirmed that the Polish children living in Dublin indeed perceived the cross-language similarity between the tested vowels differently from their adult counterparts, and that this perception ability partially predicted and explained their superior acquisition of the non-native sounds. However, native language phonology and experience effects were also found to affect the accuracy of the children's perception and production of the non-native vowels. The study concluded by suggesting that age of second language learning, quality and quantity of exposure to the target language, and cross-language phonetic similarity perception all affect acquisition of non-native vowel sounds.

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I am very grateful for the cooperation and interest of the many Polish and Irish children and adults who took part in this study. Without them, the research would not have been possible. I am particularly indebted to Danusia for help with recruiting participants for my study.

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List of abbreviations

AOA = Age of arrival to the target language country

AOE = Age of first exposure to the target language

CEFR = The Common European Framework of Reference for Languages

CPH = The Critical Period Hypothesis

DST = The Dynamic System Theory

L1 = First (native) language

L2 = Second (target) language

L2LP = The Second Language Linguistic Perceptual Model

LOR = Length of residence in the target language country

NLM = The Native Language Model

NPI = Native Polish speakers, migrant learners living in Dublin

NPP = Native Polish speakers, formal learners living in Poland

NS = Native speakers of English, living in Dublin

PAM = The Perceptual Assimilation Model

SLM = The Speech Learning Model

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Chapter 1

Introduction

> *We may in general assume sound to be a blow which passes through the ears, and is transmitted by means of the air, the brain, and the blood, to the soul, and that hearing is the vibration of this blow, which begins in the head and ends in the region of the liver.*
>
> Plato, *Timaeus* 67b

As the above citation from Plato's *Timaeus* indicates, there has been a long-standing fascination with the exploration of how humans go about decoding auditory information, and what processes and locations within the human body may be involved in experiencing a sensation such as hearing. In the area of speech processing and production, the investigation of how different speakers perceive and realize the sounds of their language(s) has since long been central to a number of domains of the language sciences, such as psycholinguistics, phonetics, phonology and applied linguistics, provoking continuous interest (as well as controversy) down to the present day. The study presented here seeks to make a theoretical and empirical contribution to the fields mentioned above from a very specific context, that of second language speech learning in today's globalizing Europe.

In the course of the past decade, the linguistic landscape of Europe has changed dramatically. In fact, around 600 languages are spoken across Europe today and all European states are becoming increasingly multilingual (VALEUR, 2007). Ireland represents one of the most striking examples of such linguistic developments; a country that has become one of the most linguistically and culturally diverse societies in Europe. According to the data collected for the 2006 Census, people from 188 different countries were resident in Ireland at the time when that research was conducted. One of the largest new communities emerging

in Ireland was comprised of the Poles, who came to be perceived as a highly educated, skilled, and well-organized community (Grabowska-Lusińska, 2008).

With the EU-enlargement to 25 member states in May 2004, Polish people could see manifold reasons to choose the Republic of Ireland as a destination to which to emigrate. It was then a country enjoying a strong economic performance, and was among the first to make its labour market fully accessible to the new EU countries. Also, the fact that Ireland is an English-speaking country, offering a great opportunity for migrants to learn or improve their abilities in the *lingua franca* of the globalizing world, was probably an important factor that attracted many Poles. In addition, there are cultural commonalities between the two countries, which might have made Polish migrants feel more at home in Ireland than perhaps they would elsewhere in Europe: both are largely Catholic countries, where religion has traditionally been linked with national identity; both have had a history of occupation by bigger neighbours; and both have experienced mass emigration in their past.

The greatest challenge faced by Poles on arrival in Ireland may not, therefore, have been so-called culture shock, but rather the host community language. Irish English is characterized by a degree of distinctiveness in vocabulary, construction, and pronunciation. Particularly in terms of certain sounds, this variety of English can pose a great challenge for the unaccustomed ear. In addition, the post-accession Poles have been reported to often lack confidence in communicating in English in various social situations in Ireland despite the fact that they had experienced a number of years of formal English instruction in their home country before migration (Kopeckova, 2008; Kropiwiec and King-O'Riain, 2006; Singleton *et al.,* 2007). The very same reports point out, however, that the Polish community showed itself to be highly ambitious and motivated to acquire English to advanced levels of proficiency. *The present study therefore asks how Polish people perceived and produced specific (Irish) English vowel sounds after about three years of*

migration experience in Ireland. An understanding of how second language (henceforth L2) learners of different age groups and L2 experience come to grips with L2 speech carries both theoretical and practical significance. Theoretically, achieving such an understanding is important for possible explanations of age-related differences in L2 speech learning, and for the advancement of adequate L2 speech models. In practical terms, such an understanding may help to determine what types of training and encouragement may be most effective for diverse L2 learners.

Previous studies suggest that, overall, younger learners are more successful at acquiring L2 speech than are their adult counterparts (Asher and Garcia, 1969; Baker *et al.*, 2008; Flege, MacKay and Meador, 1999; Oyama, 1976). One reason for this early learner advantage might be the state of development of the native language (henceforth L1) sound system when L2 learning begins. As long-term memory representations (categories) for L1 vowels and consonants become better defined, it may be increasingly difficult for adults to treat L2 sounds independently from their L1 sound categories. By contrast, child L2 learners' representations for L1 sounds are still evolving and as such may influence their L2 speech learning less. Consequently, young L2 learners may be better able to perceive and produce L2 sounds accurately (Flege, 1995, 2003a; Flege, MacKay and Meador, 1999; Baker *et al.*, 2002, 2008). *The main purpose of this study is to determine to what extent the state of development of the native language sound system at the time of L2 learning indeed influences how accurately L2 sounds are learned.*

Second, some L2 sounds may pose a greater learning challenge than others, whether encountered by children or adults. Current L2 speech learning models posit that L2 sounds that are similar to L1 sounds are more difficult to learn than dissimilar (new) L2 sounds. This is because similar L2 sounds are likely to be readily assimilated to existing L1 categories, leading to inaccurate perception and production of such segments (Aoyama *et al.*, 2004; Best, 1995; Flege, Bohn and

Jang, 1997; MacKay *et al.,* 2001). A controversy exists around the question of whether children are less likely than adults to assimilate L2 sounds into L1 categories, and whether this might also be true for similar L2 sounds (cf. Baker and Trofimowich, 2005; Baker *et al.,* 2008). *Another purpose of this study is, thus, to examine the effect of perceived cross-language phonetic similarity in L2 learners of diverse age groups in respect of their perception and production of non-native sounds.*

Finally, L2 learning experience is also likely to influence the extent to which L2 sounds are perceived and produced accurately. Experienced learners, i.e. those who have been exposed to an L2 in a naturalistic environment for a substantial period of time and/or those who use their L2 more often, may perceive and produce L2 sounds more accurately as they gain experience in the target language (Flege, Bohn and Jang, 1997; Flege and Liu, 2001; Levy and Strange, 2008). In addition, L2 experience effects may be more apparent for children than for adults, because the former may be exposed to a significantly richer L2 environment and/or because their learning goals and underlying aspirations may be different (Jia and Aaronson, 2003; Tsukada *et al.,* 2005). *This study thus seeks to determine the extent of L2 experience effects on L2 speech learning of child and adult migrant learners.*

To this end, a group of 20 Polish children and 20 Polish adults, who had lived in Dublin for about 3 years at the time of the study, performed the following language tasks: 1) a cross-language identification task, to determine their perception of similarities between chosen L1 and L2 vowel sounds; 2) a categorical discrimination task, to determine their perception of L2 vowels; and 3) a delayed repetition task, to test their production of the L2 sounds. In addition, data on the participants' language learning histories, attitudes and contact with Polish and English were elicited by means of a detailed background questionnaire and a semi-structured interview. These data were elicited in order to ascertain how age at the time of L2 learning, cross-language phonetic similarity perception, and L2 learning

experience influence L2 learners' discrimination and production of specific non-native vowel sounds.

Although the study of L2 speech learning in early and late L2 learners has received considerable attention in previous research, studies in this area have rarely focused on direct comparisons of children and adults at the time of their L2 acquisition. Undertaking such a comparison is important for testing the possibility that the state of development of the L1 sound system at the time when L2 acquisition begins, affects the perception of similarities between L1 and L2 sounds, and consequently, the perceptual and productive accuracy of L2 sounds. In addition, the study presented here is unique in its combination of quantitative and qualitative data analyses of L2 speech learning. Finally, the fact that this study is located within the realms of Polish and Irish English languages allows for testing a number of specific predictions advanced by current models of L2 sound learning and processing.

The remainder of this thesis is structured as follows: Chapter 2 discusses, in the light of previous research, the role of native language, age of L2 learning, and linguistic as well as non-linguistic experience in L2 phonological acquisition. In addition, in this chapter, the rationale, motivation and theoretical significance of the study are explained, and the research hypotheses are formulated. Chapter 3 explains the methodology of the study, while Chapter 4 presents the obtained results. Chapter 5 discusses the findings and explores their implications. The limitations to this study are then adumbrated, followed by suggestions for future research.

Chapter 2

Second language speech learning

1. Introduction

This chapter provides an overview of the major issues and findings emerging from research on second language speech learning which are relevant to the focus of this study. First, L2 speech learning models are scrutinized. Second, age and potential sources of age effects in L2 acquisition, such as maturation, native language development, and L2 experience, are discussed. Third, research and theory on non-linguistic factors in L2 acquisition are presented. Finally, the rationale, motivation and theoretical significance of this study are explained, and the research hypotheses are formulated.

2. Second language speech learning models

In our multilingual world, everyday experience of foreign accents is commonplace. This is not surprising given the variety of factors that could potentially intervene in the way L2 speech is perceived and produced. Such factors include, among others, a (perceived and/or actual) phonetic distance between the native and non-native sounds, age at which L2 learning starts, experience with learning the L2, and motivation to appear native-like. Any or all of these are likely to influence L2 speech learning to various degrees at different moments of L2 development. The most recent theorising even goes so far as to suggest that long-term predictions of L2 (phonological) acquisition cannot be reliably made, given the constantly changing interaction of a large number of variables involved in the learning process (Lowie, 2010). Previous research has documented and recognized the complexity of L2 speech learning, thereby giving rise to several theoretical

models that attempt to explain developmental changes in the ability to acquire new speech sounds. The two most influential models at present are Best's Perceptual Assimilation Model (PAM) and Flege's Speech Learning Model (SLM), and these two models form the theoretical motivation for this present study. Two other models relevant to this study, Kuhl's Native Language Magnet Model (NLM) and Escudero's Second Language Linguistic Perceptual Model (L2LP), will also be considered. Despite some divergent foci, the four models are in accord on the significance of prior native language processing in learning to perceive and produce L2 speech; hence the starting point of the existence of foreign accents. The main notions advanced by the models are outlined in the sections to follow, and these serve as a theoretical springboard for predictions advanced in this present study about the challenges that Polish children and adults are likely to experience on their path of learning English vowel sounds in Dublin.

2.1. The Native Language Magnet Model

Kuhl's NLM (2008) model explains the developmental changes in *auditory perception* which take place *during the infant's first years of life*. Having researched children from about 2 to 24 months of age, Kuhl and her colleagues have documented a dramatic shift from a language-universal pattern of phonetic perception to a language-specific pattern, in which contrasts that are linguistically relevant in the ambient language continue to be well-perceived, while those non-native phonetic contrasts that are redundant in native language acquisition are no longer discriminated accurately (e.g. Kuhl *et al.,* 1992; Iverson *et al.,* 2003; Polka and Werker, 1994). These findings are interesting, in that they suggest that humans are born with a unique ability to attend to the sounds of any language, but that this ability diminishes as our experience and need for social interaction in the native language increases. These results have been interpreted as evidence for a *perceptual magnet effect*:

> As experience accumulates, the representations most often activated (*prototypes*) begin to function as perceptual magnets for other members of the category, increasing the perceived similarity between the members of the category ... this distortion of perception, termed *perceptual magnet effect*, produces facilitation in native and a reduction in foreign language abilities (Kuhl *et al.,* 2008; p. 982).

Kuhl *et al.* (2008) have shown that this type of early learning experience results in changes in the neural tissue and circuitry of infants' brains; the point being that as the infants' 'statistical' learning—i.e. sensitivity to the distributional frequencies of the sounds around them—proceeds, neural networks become committed to the native language speech patterns. On this basis, children are better at acquiring the sound system of an L2 than adults, whose neural commitment to the native language sound patterns is already complete. An important question arising from this finding is whether there is any flexibility to such a neural commitment. In a study of American infants exposed to Mandarin Chinese during an intensive four-week learning session, Kuhl *et al.* (2003) demonstrated that the decline typically observed in foreign language speech perception can be reversed, to the extent that this group performed comparably to infants raised in Taiwan. This result, however, was only found for a testing situation in which a live speaker interacted with the American infants. Those infants who were exposed to Mandarin Chinese for the same period of time via a DVD programme showed no evidence of phonetic learning. The authors speculated that it was the quality of live infant-directed speech which enhanced attention, arousal and noticing abilities in the children, and facilitated their successful phonetic learning in respect of the target language perception. The conclusion drawn from this and other infant experiments run in Kuhl's laboratories was, therefore, that a sensitive period for phonetic learning appears to remain flexible until the number and variability for particular sound categories reach stability, aiding language-specific speech perception and production (Kuhl *et al.,* 2005). A visual representation of the NLM model is depicted in Figure 2.1. below.

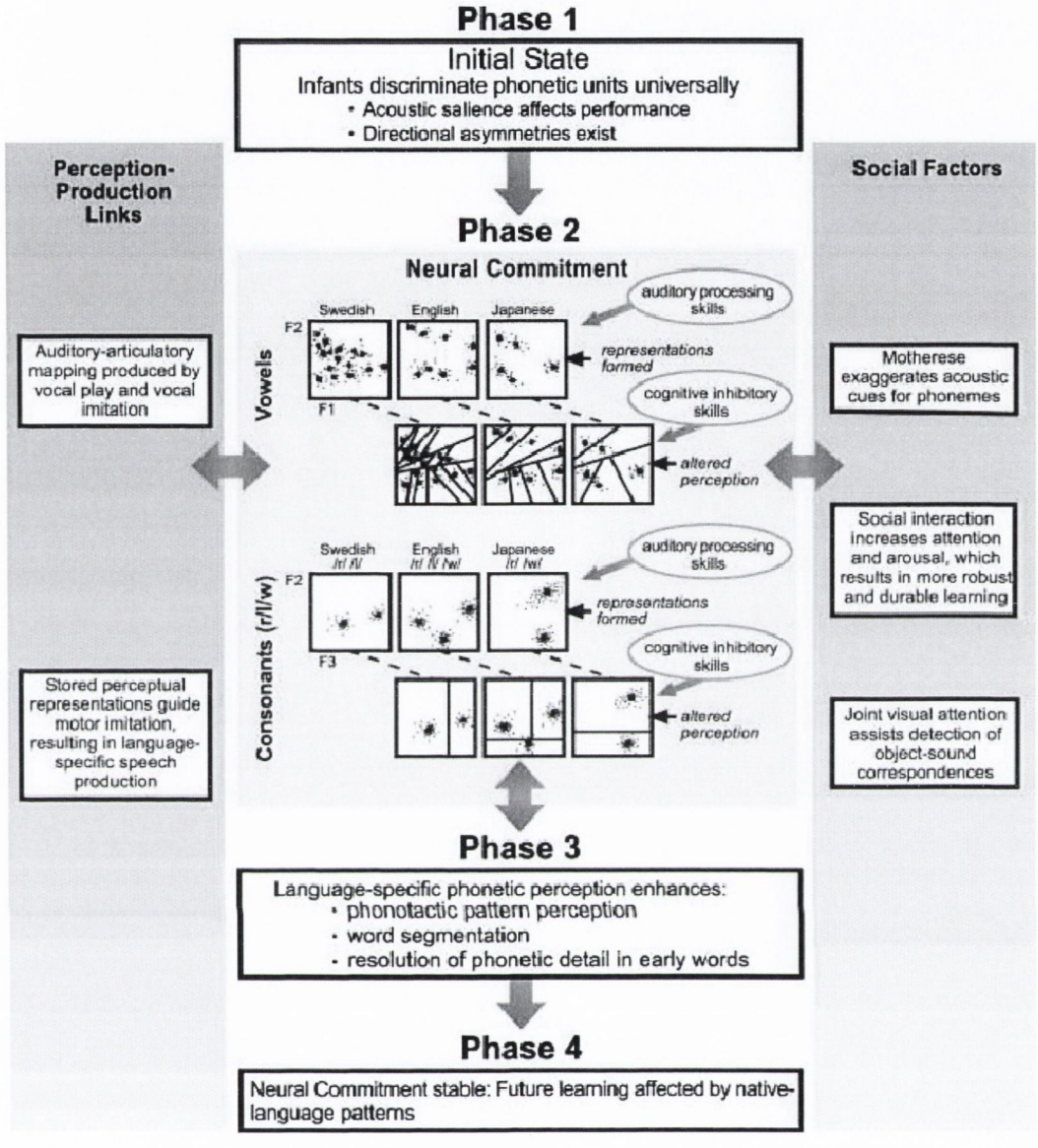

Figure 2.1. Model of infant phonetic learning: Native Language Magnet-Expanded (reproduced from Kuhl et al., 2008)

It is reasonable to suppose that the type of early phonetic learning just described will have consequences for adult perception, to the extent that those non-native sounds which do not correspond to the criteria for category distinctions in the native language may be more difficult to learn. Specific predictions for adult learners' development of L2 perception, as advanced by the Perceptual Assimilation Model (1995, 2007) and the Second Language Linguistic Perceptual Model (2005) are presented in the following two sections of this chapter.

2.2. The Perceptual Assimilation Model

Best's PAM (1995) aims to explain *perception of non-native contrasts* by learners who have no linguistic experience with the target language. More recently, however, Best and Tyler (2007) have expanded the model to predict patterns of speech perception also by L2 learners in the course of L2 acquisition (PAM-L2). Notions relevant to the focus of the current study, as explicated in both versions of the model, are presented below.

Taking a direct realist position, PAM posits that inexperienced learners exposed to non-native sounds rely on information about articulatory gestures from the speech signal, which they are likely to interpret within the existing native segmental constellations:

> [N]on-native segments ... tend to be perceived according to their similarities to, and discrepancies from, the native segmental constellations that are in closest proximity to them in native phonological space. Because the universal phonetic domain and native phonological space are defined by the special layout of the vocal tract and the dynamic characteristics of articulatory gestures, those distal properties provide the dimensions within which similarity is judged (Best, 1995, p.193).

Depending on the level of perceived articulatory similarity of the sounds, Best (1995) suggested that a non-native sound can be heard as a good or a poor example of a native phone (*Categorized*), as different from any particular native phoneme (*Uncategorized*) or, as a non-speech sound (*Non–Assimilated*). Accordingly, at least four pair-wise assimilation types associated with different levels of L2 discrimination difficulty are possible. These are explained in greater detail below and outlined in Table 2.1.

First, both sounds of a non-native contrast can be judged as members of a single native sound category. When both members of the non-native contrast are perceived as good or equally poor members of a single native language category (*Single-Category Assimilation*), then the discrimination will be very poor. However, if one sound of the non-native contrast is perceived as a much poorer member of

the native language category than is the other (*Category-Goodness Assimilation*), then discrimination between these two non-native sounds may range from moderate to very good, depending on how dissimilar the two non-native sounds are from the L1 sound category. Further, if the two contrasting sounds occur in high frequency words, or come from such phonological neighbourhoods that contain many minimally contrasting words, the lexical pressure to learn the distinction may be quite high (Best and Tyler, 2007). An example for adult Polish learners of English might be English /i/ and /ɪ/ (as in *beat* and *bit*, respectively), both of which are likely to be perceived as members of the Polish category /i/ and therefore poorly discriminated at the beginning of their L2 learning; however, the need for adequate distinction may encourage the Poles' perceptual learning of the L2 contrast. As their experience with the target language increases, Polish speakers may come to perceive the English vowel /ɪ/ as close to yet another Polish high vowel /ɨ/, and thus come to discriminate the contrast as a Two-Category, rather than a Single-Category case.

L1/L2 relationship	**Example**	**Discrimination**
Single-Category	English /i/ and /I/ with Polish /i/	Poor
Category-Goodness	English /ɔ/ and /əʊ/ with Polish /o/	Moderate to very good
Two-Category	English /ɛ/ and /I/ with Polish /ɛ/ and /i/	Excellent
Categorized-Uncategorized	Irish English /u/ and /ɔ̈/ with Polish /u/	Poor to very good

Table 2.1. L1/L2 relationships and ease of discriminating L2 contrasts (according to PAM, 1995)

Another possible pattern for discrimination of non-native contrasts occurs when the two non-native sounds are perceived as members of two separate non-native language categories (*Two-Category Assimilation*). Discrimination of this type of contrast is predicted to be excellent. An example of this situation can be English

/ɛ/ and /ɪ/ vowels (as in *bet* and *bit*, respectively) compared to Polish /ɛ/ and /i/. The discrimination of these L2 sounds by native speakers of Polish, even at the beginning of their L2 learning, is predicted to be very good, since each segment is assimilated into a different native category.

The fourth pattern occurs when one member of the non-native contrast is perceived as a member of a native language category and one is perceived as uncategorizable (*Categorized-Uncategorized Assimilation*). Such a contrast should be discriminated well, because it reflects a phonological distinction between an exemplar of a known phoneme and an unknown sound. However, a study by Guion *et al.* (2000) showed that this contrast type can be discriminated poorly when the uncategorized sound is in close phonological space to the categorized sound. A possible sound contrast that might fit this pattern is Irish English /ɔ̈/ and /u/ (as in *but* and *boot,* respectively) since Irish English /ɔ̈/ is probably perceived as uncategorizable by Polish speakers.

Finally, PAM describes a rare case when both non-native phonemes are so deviant from the articulatory properties of native phonemes that they are not perceived as speech sounds at all. In PAM's terminology, they are both *Non-Assimilable*. For instance, discrimination of Zulu clicks by native English listeners was found to follow this pattern and proved to be excellent (Best, McRoberts, and Sithole, 1988).

A core question for PAM has been whether L2 contrasts that are initially difficult to differentiate can eventually be learnt and perceived accurately. Best and Tyler (2007) argued that L2 learners do continue to refine their perception of speech gestures as their experience with learning an L2 increases. This refinement of perception entails not only the apparently greater exposure to native productions of specific L2 contrasts, but also experience with producing the target contrasts, and, most importantly, formation of lexical items in the target language. PAM predicts, however, that those L2 pairs that continue to be perceived as good

members of a single L1 sound category, at both phonetic and phonological levels, are likely to show very little phonetic learning.

To summarize, PAM maintains that L2 perceptual learning is based on direct perception of the articulatory gestures and develops with growing L2 experience. The way phonetic information is perceived is, however, constrained by an individual's experience with learning both their non-native language and native languages, hence the pervasiveness of 'foreign accent in L2 perception' in the case of some non-native contrasts. An interesting issue arising in this regard is that of a learning situation in which the ambient language environment changes as a function of L1 and/or L2 dialectal variation. This question of individual differences in L2 perceptual development is addressed in the Second Language Linguistic Perceptual Model (2005), which is discussed next.

2.3. The Second Language Linguistic Perceptual Model

Drawing on some elements from PAM, Escudero's L2LP model (2005) attempts to describe and explain the process of *L2 perceptual development in adult L2 learners*. It begins with the assumption that at the start of L2 acquisition, L2 learners create a copy of their L1 perceptual system (*Full Copying Hypothesis*) to prepare a 'template' for the perception of non-native sounds, on the one hand, and to leave the original L1 sound system unaffected, on the other (Escudero, 2005). This model thus predicts that phonological transfer occurs only once, at the onset of L2 acquisition. This hypothesis is significant, in that it suggests that bilinguals might be able to keep their L2 and L1 perceptual systems separate as their L2 speech learning progresses. Eventually, such learners could potentially attain native-like perception in both their languages (cf. Best and Tyler, 2007; Flege, 1995; Grosjean, 2001).

According to the L2LP model, the primary setting for L2 perception is likely to differ substantially among L1 speakers, considering that perception may be shaped by specific acoustic properties of the native accent, including regional, social

and idiosyncratic characteristics (Mayr and Escudero, 2010). In addition, the individual primary setting for L2 perception comes to be shaped by the production environment of the target language, which, again, may show specific dialectal features. For instance, Escudero and Boersma (2004) found that Spanish learners of Scottish English used different phonetic cues for discriminating the vowel contrast /i/-/ɪ/ than did Spanish learners of Southern British English. The authors thus argued that L2 learners come to categorize L2 sounds in accordance with the productions of the ambient L2 environment, rather than with a standard target language variety that they might have first been exposed to.

According to the L2LP model, L2 perceptual performance of the learner is guided by their perceptual mappings of L2 sounds into L1 categories, and is a result of two main learning scenarios—the acquisition of *similar* L2 contrasts and the acquisition of *new* L2 contrasts[1]. Specific predictions, as advanced in the L2LP model, are explained and outlined in Table 2.2.

L1/L2 relationship	**Example**	**Learnability**
New (Single-Category in PAM)	English /i/ and /I/, and Polish /i/; Irish English /ɔ/ and /əʊ /, and Polish /o/	Very difficult
Similar (Two-Category in PAM)	English /ɛ/ and /I/, and Polish /ɛ/ and /i/; English /i/ and /I/, and Polish /i/ and /I/	Not difficult

Table 2.2. L1/L2 relationships and learnability of L2 contrasts (according to the L2LP model, 2005)

When similar L2 pairs are learned, the task is to reuse existing L1 categories and shift the native perceptual boundaries to match that of the second language. This is considered to be a relatively easy task for the learner to do, yet requiring some learning effort. For example, some Polish learners of English may perceive that the L2 contrast /i/ and /ɪ/ (as in *beat* and *bit,* respectively) has a production

[1] Escudero (2005) also describes a third learning scenario (*subset* in L2LP terminology), referring to L2 sounds that already exist in the L1 but have multiple L1 correspondents, i.e. this is a case of an L1 sound system which contains more sound categories than that of an L2. This scenario is not relevant to the Polish-Irish English vowel sound relationships, and therefore not described here.

distribution that overlaps with the acoustic-auditory regions of Polish /i/ and /ɪ/ (as in *bity* and *byty,* respectively). However, with L2 experience, they might come to perceive that there is a degree of mismatch between the sounds concerned. Therefore, their learning task will be to adjust the initial L1-like perception of the contrast to the location of the L2 boundaries concerned.

The other scenario occurs when L2 environment produces phonological differences which do not exist in the L1. The learning of such new L2 contrasts is predicted to be very difficult, since L2 learners face a much more complex task here. It involves creating new perceptual mappings, forming new phonetic categories, and integrating the newly categorized dimensions into the existing ones. For example, Polish learners acquiring the Irish English contrast /ɔ/ and /əʊ/ (as in *bought* and *boat*, respectively) may face such a learning task.

Yet, both learning scenarios, if supported by rich L2 input, may eventually lead to native-like L2 perception. Escudero's (2005) explains that:

> [U]nder the proper circumstances, L2 sound perception can develop to reach the optimal target L2 perception level. This L2 development will occur without affecting the optimal L1 perception which will remain stable if the learner is exposed to sufficient L1 input. ... [T]he speed and path of development will be different depending on the specific L2 perception task the learner needs to face (p. 121).

The L2LP model thus offers a theoretical account of individual routes of L2 perceptual development, resulting from the variability in cross-language mapping patterns. This is especially relevant for learners of English who might have been exposed to different varieties of the English language during their L2 learning. Polish learners of English residing in Dublin may exemplify such a specific learning experience—their perception of some English contrasts may originally have been mapped according to British English or American English accents, depending on their previous English learning experience, but for some learners perception of L2 contrasts may later have shifted, as a result of their new exposure to Irish English.

In its predictions on separate L1 and L2 perception systems and levels of difficulty for different learning scenarios, the model positions itself in contrast to yet another theoretical model which motivates much of the current research in the area: the Speech Learning Model (1995). Following a discussion of this model below, a summary of the main differences between the L2 speech learning models reviewed here is presented.

2.4. The Speech Learning Model

Flege's SLM (1995) offers a comprehensive account of *the development of L2 speech perception and production throughout life span*. It also predicts how factors, such as age at the time of L2 learning, native language use, and L2 input, affect the ability to perceive and produce non-native sounds in a native-like fashion.

The fundamental argument postulated by the model states that "[t]he mechanisms and processes used in learning the L1 sound system, including category formation, remain intact over the life span and can be applied to L2 learning" (Flege, 1995, p. 239). Like the L2LP model, SLM thus allows for the possibility of native-like L2 performance; however, it also argues that L2 learners, by definition, will differ from monolingual speakers in some aspects of their performance because they are users of two languages, rather than one, and have an extensive experience with learning and using their native language. This is likely to influence the way L2 learners perceive and produce non-native sounds. In addition, SLM predicts that an extensive exposure to an L2 may affect the way native sounds are perceived and produced, since L1 and L2 categories are predicted to exist in a common phonological space, and therefore to influence one another (Flege, 1995; Flege, Schirru and MacKay, 2003; Grosjean, 2001).

SLM proposes two mechanisms through which L1 and L2 sound systems interact: *phonetic category assimilation* and *phonetic category dissimilation*:

> The mechanism of phonetic category assimilation yields merged L1-L2 categories. Such categories are used to process L1 and L2 speech sounds that continue to be perceived as instances of a single category. The merged categories reflect the phonetic properties of L1 and L2 speech sounds that have been perceptually equated. The mechanism of phonetic category dissimilation, on the other hand, yields L1 and L2 categories that are adjacent to one another in phonetic space, but have deflected away from one another to preserve phonetic contrast (Flege, 2002; pp.238-239).

The existence of the mechanism of phonetic category assimilation has been documented in a number of studies to date, most notably MacKay *et al.* (2001). In this study, both early and late Italian-English bilinguals were shown to perceive and produce English consonants less accurately than English monolinguals (albeit to varying levels), with some early bilinguals showing a shifted L1 production in the direction of the L2 norm. The authors interpreted the results as demonstrating that these bilinguals used only a single merged category in the identification of the tested consonants in English, producing the English and Italian sounds accordingly. Flege, Schirru and MacKay (2003) demonstrated the existence of the mechanism of phonetic category dissimilation in yet another study with Italian-English bilinguals. This time, early bilinguals who seldom used their L1 were shown to exaggerate the movement of English /e^{I}/ in their L2 productions to dissimilate the sound from Italian /e/. In an earlier study by Flege and Eefting (1986), a similar finding was reported for the perception and production of L2 stop consonants by Dutch advanced learners of English.

The results of these and other studies led to the formulation of the SLM hypothesis about the course of L2 phonological development in L2 learners of diverse age groups:

> [A]s L1 phonetic categories develop slowly through childhood and into early adolescence, they become more likely to perceptually assimilate L2 vowels and consonants. If instances of an L2 speech sound category persist in being identified as instances of an L1 speech sound, category formation for the L2 speech sound will be blocked. (Flege, 2003a; p.10)

On this view, adult (late) L2 learners are likely to subsume L2 sounds into L1 categories owing to the assimilative power of their relatively stable L1 sound system, and thus fail to form new categories for L2 sounds. Assimilating L2 sounds into L1 categories, adult learners are less likely to perceive and produce L2 sounds accurately. Child (early) learners, in turn, are predicted to be less influenced by their evolving L1 sound system, and thereby are more likely to form separate categories for L2 sounds and so to learn the target language sounds to native-like levels.

Flege (1995) predicts, however, that the effect of native language phonology will be especially persistent for certain L2 sounds, whether learnt by adults or children. Specifically, SLM posits that L2 sounds that are perceived as distinct sounds, with no L1 counterparts to be compared with and assimilated to, will be easier to learn because phonetic differences between such sounds can be easily detected, leading more readily to the formation of separate categories for such L2 sounds. In contrast, similar L2 sounds will be difficult to learn, as L2 learners might not be able to perceive the subtle phonetic differences between the L2 and L1 sounds concerned. Specific SLM predictions about the difficulty of learning L2 sounds as related to perceived cross-language similarity are described in greater detail below and outlined in Table 2.3.

L1/L2 relationship[2]	**Example**	**Ease of learning**
Very similar	English /i/ and Polish /i/	Difficult (but without notable foreign accent)
	English /I/ and Polish /i/	Difficult (with notable foreign accent)
Somewhat similar	English /ɔ/ and Polish /o/	Difficult
Distant	Irish English /ɔ̈/ and Polish /u/	Easy

Table 2.3. L1/L2 relationships and ease of learning of L2 sounds (according to SLM, 1995)

[2] Originally, the terms *identical*, *similar*, and *new* were used in SLM to describe the relationship between L2 and L1 sounds. Currently, L2/L1 comparisons in SLM are made in terms of "degrees of perceived phonetic similarity".

The first type of L2/L1 relationship outlined in SLM refers to L2 sounds that are perceived to be very similar to L1 sounds. These sound segments have been hypothesized as being most difficult to learn, although no notable foreign accent may be heard on those L2 sounds that are acoustically only slightly different from L1 sounds (Flege, MacKay and Meador, 1999). For example, Polish learners of English can be expected to produce the English /i/ with only a slight foreign accent, because they would tend to perceive and produce the sound as Polish /i/, a segment that is acoustically close to English /i/. Polish speakers' production of English /ɪ/, however, is likely to be notably accented, because this vowel is to be replaced by Polish /i/, a segment acoustically different from English /ɪ/. Similar difficulties in learning to produce English high vowels were noted for Spanish, Mandarin and Korean speakers (Flege, Bohn and Jang, 1997).

The second type of L2 sounds explored in SLM are also perceived as similar to an L1 sound, but in this case the learners can hear that the L2 sound is not a good instance of the L1 counterpart (Flege, Munro and Fox, 1994). An example of this type of sound would be Polish /o/ and English /ɔ/. These sounds have similar spectral properties, but, because the English /ɔ/ is often a diphthong and has a longer duration than Polish /o/, they may not be perceived as being highly similar. These sounds are nevertheless hypothesized to be assimilated to an L1 category and produced inaccurately even at later stages of L2 acquisition.

Finally, the third type of sound considered in SLM comprises those that do not exist in the native language. These sounds are predicted to be the easiest to acquire, because they do not interfere with the existing L1 categories. However, they may be challenging to produce for beginning adult learners (Flege, Bohn and Jang, 1997). An example of this situation for native Polish speakers may be Irish English /ɔ̈/. Native speakers of Polish may first produce this sound close to Polish back vowels /u/ or /o/, but with further exposure to Irish English, they may shift

the production of the sound to that resembling more closely the target mid-centralized, rounded, back vowel.

To summarize, the SLM (1995) maintains that the ability to perceive differences between L1 and L2 sounds facilitates L2 category formation, which, in turn, is likely to aid accurate L2 perception and production. Child L2 learners' ability to do this seems to be better than that of older L2 learners, as children's L1 sound system is still developing and thus does not constitute as strong an "attractor" of L2 sounds. Finally, the extent to which L2 speech can be mastered to advanced levels is predicted in the SLM model to be affected, in addition to age-related changes in cross-language phonetic similarity perception, by L2 input, as well as by L1 use (experience effects in L2 speech learning are discussed in Chapter 2, Section 4). A visual representation of the SLM model is displayed in Figure 2.2. below:

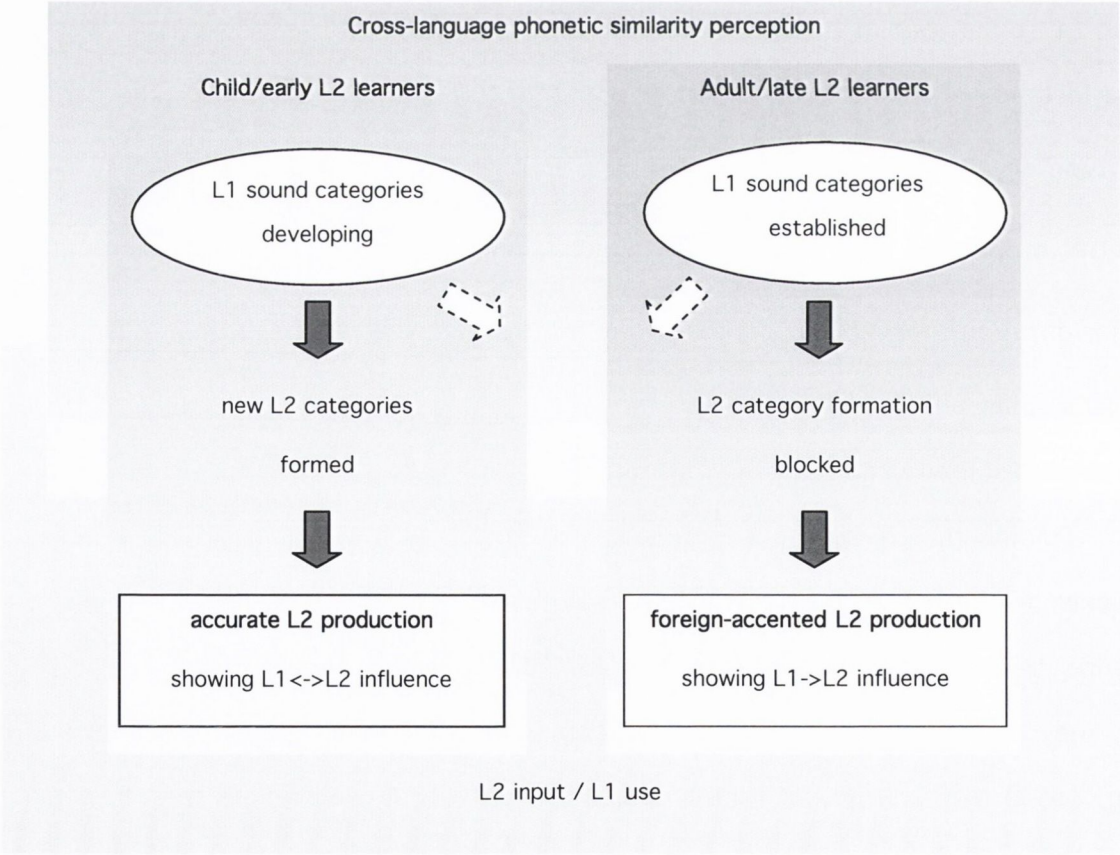

Figure 2.2. Model of child/adult L2 phonological acquisition: The Speech Learning Model (Flege, 1995)

2.5. Comparison of the L2 speech learning models

As discussed above, current L2 speech learning models relate the development of perception and production abilities in an L2 to the perception of cross-language phonetic similarity. Specifically, NLM, PAM and SLM predict that the more similar an L2 sound is to a native language category, the more difficult it will be for L2 learners to perceive this sound accurately. In contrast, sounds that are more distant across the L1 and L2 are expected to be discriminated well, especially as experience with learning such L2 sounds increases. Although they are in accord on their predictions of learnability of specific L2 sounds, the models outlined above diverge in their explanation of the processes involved in L2 speech learning. Whereas PAM posits that L2 learners directly extract information about articulatory gestures from the speech signal, SLM focuses on the development of phonetic categories from acoustic-phonetic cues. NLM claims that early phonetic learning is constrained by auditory-based mappings that have committed neural structure towards native language processing.

Unlike the other three models, the L2LP model predicts that the learning of all L2 sounds poses a learning challenge, although the learning tasks will be different for those L2 sounds that are perceived as similar and those different from L1 sounds; the letter being more difficult to acquire because new L2 sound categories are to be based on previously unknown dimensions and mappings.

The models presented above also differ in their focus on diverse learner groups and stages of development. While NLM examines perception abilities of infants, PAM was developed to explain non-native speech perception mainly by adult naïve listeners. SLM and L2LP models, in turn, aim to address L2 speech development across time. Finally, the SLM is the only model of the four under discussion which explicitly addresses the development of both perception and production abilities in an L2, and predicts a bidirectional L1<–>L2 interaction in learning non-native speech. Offering a comprehensive account of L2 speech

learning across the life span, the SLM forms the theoretical motivation for the current study. The main differences between the four L2 speech learning models considered here are summarized in Table 2.4.

L2 model	Focus	Learner (stage of development)	Learning processes	Predicted L1/L2 interactions
NLM	L2 perception	Infant	Auditory-based maps, L1 neural commitment	L1 -> L2
PAM	L2 perception	Infant and adult L2 learner (beginner)	Articulatory gestures	L1 -> L2
L2LP	L2 perception	Adult L2 learner (all stages)	Linguistic mappings, phonological categories	L1 -> L2 (at the onset)
SLM	L2 perception and production	Child and adult L2 learner (all stages)	Acoustic-phonetic cues, phonetic categories	L1 <-> L2

Table 2.4. Current L2 speech learning models compared

3. Measurements of cross-language phonetic similarity

Given the main assumption of the current L2 speech learning models about the role of perceived cross-language phonetic similarity in L2 speech learning, an important empirical issue arising in this regard is that of a characterization of the phonetic distance between L1 and L2 sounds. It is reasonable to suppose that comparisons made at an abstract level, for example, by transcriptions within the International Phonetic Alphabet (IPA), may not be accurate, because the same phonetic symbols can be used across languages while describing acoustically different sounds. *Acoustic analyses* of cross-language phonetic similarity, instead, work with much greater precision in measurement; for example, when similarities between vowel inventories of two languages are to be established, formant frequencies (resonant frequencies of the vocal tract) of the relevant vowel sounds are measured and compared. However, this type of measurement can also be problematic, because acoustic analyses inevitably involve comparisons of different speakers whose productions may reflect differences in the size and shape of their

vocal tracts, rather than differences in the spectral properties of the speech sounds concerned. Strange (2007) listed a number of other methodological difficulties related to comparisons of cross-linguistic acoustic similarity, concluding that "cross-language comparisons should be conducted at levels of analysis more closely related to the actual phonetic realization of the abstract phonological categories as they are perceived by the listeners" (p.37). Note that the L2 speech learning models by which this study is motivated do, in fact, work with the notion of the *learner's judgement of perceptual similarity*, rather than with cross-language spectral and temporal similarity.

Previous research has used diverse tasks to test L2 learners' perception of cross-language phonetic similarity, with the most common used at present being transcriptional and perceptual assimilation tasks. In a transcriptional task, listeners are asked to write what the presented segments "sounded like", using orthographical labels to which they can add diacritics and various comments (e.g. Best *et al.,* 2001). Although practical and direct in form, this method of measuring cross-linguistic phonetic similarity may be potentially problematic for a number of reasons. First, differences in orthographic systems across languages may influence the listener's decision about differences between L1 and L2 sounds (Piske *et al.,* 2002; Bassetti, 2008). Also, transcriptions may not be appropriate for use with listeners who are not familiar or comfortable with transcribing sounds, which may hold especially true for children. Finally, this type of measurement does not inform us about *the degree of similarity* between specific L2 and L1 sounds. This is where the use of perceptual assimilation tasks may be more insightful. In a perceptual assimilation task, L2 learners are asked to match presented L2 stimuli with L1 categories represented orthographically or by key words; they are also asked to make goodness-of-fit judgements regarding the similarity of the L2 sound and the L1 category they had chosen, using a Lickert scale (e.g. Guion *et al.,* 2000; Cebrian, 2006; Strange, 2007). A similar type of perceptual assimilation task was

used in this current study with Polish children and adults, judging (Irish) English vowel sounds. Key words in their native language, read aloud by the participants themselves, were used in order to support the participants comparing the L2 phones against their own internal representations of L1 phonetic categories. The use of this task, rather than a transcriptional task, was further motivated by the fact that the two previous studies that investigated the effect of perceived cross-language phonetic similarity on L2 speech learning (Baker *et al.*, 2002, 2008) showed that children aged as early as eight years can perform the task as intended.

In the following section, research and theory on the factor of age in L2 acquisition and, specifically, L2 speech learning, are discussed. After the extant findings on L2 vowel perception and production among L2 learners of diverse age groups are presented, the most frequent theoretical accounts of child-adult differences in L2 acquisition are scrutinized.

4. Age in second language speech learning

The effects of age on the outcome of L2 learning represents one of the most captivating themes in the field of applied linguistics. It continues to be hotly debated, not only among researchers and practitioners, but also among policy makers and the general public (Scovel, 2000; Muñoz, 2008). Before any further discussion of age effects in L2 acquisition, however, it is important to clarify how previous research has understood and used the related terminology.

In research into L2 acquisition, "age" typically refers to the *chronological age at which L2 learning began*. For naturalistic learners, this often coincides with *age of arrival* (AOA) to the target language country, marking the learners' first substantial exposure to native speaker input and experience with using the L2 on a daily basis. However, for some learners, *age of first exposure* (AOE) to the target language may represent still another measure, if, for example, they had first

started to learn the language in a formal setting. This is the case for most of the Polish adults in the present study, who reported some exposure to English before moving to Ireland, via classroom instruction with mainly non-native teachers. Such exposure would typically be regarded as insignificant in terms of L2 acquisition, and L2 phonology in particular, because it indicates a qualitatively and quantitatively limited contact with the target language.

When referring to different age groups of participants, previous research has used the terms "early bilinguals", "early L2 learners", "early starters" or "child L2 learners" to define those learners who began to acquire an L2 at a young age. The upper age limit for this group of learners is commonly set at about puberty, to control for the possibility of a critical period for language learning (see discussion on this theme below). In turn, "late bilinguals", "late L2 learners", "late starters", "adult L2 learners" are considered to be learners who acquire an L2 in adulthood. To avoid confusion, further discussion on the age factor in L2 speech learning as reported in individual past studies follows the terminology used in the original research.

4.1. Age effects on L2 vowel perception

Previous research examining segmental perception by early and late starters indicates that early bilinguals commonly perform more accurately than late bilinguals in L2 perception tasks, although their performance may differ from that of native speakers. For example, Flege and MacKay (2004) found that native Italian speakers with AOA between 2 and 13 years were more accurate in perceiving differences between diverse English vowels than those Italian speakers with AOA between 15 and 26 years. Nevertheless, those early learners who reported frequent L1 use differed significantly from native speakers of English in their performance, as opposed to those who used their L1 seldom. In a longitudinal study, Tsukada *et al.* (2005) found that native Korean children were better able to discriminate English vowels than were native Korean adults after both three and five years of residence

in North America. However, the Korean children with three years of residence received significantly lower scores for all four English vowel contrasts that were tested in the study than did age-matched native children, whereas the Korean children with five years of residence performed with native-like ability in discriminating two of the contrasts. The results of these studies thus suggest that those who begin to learn an L2 in childhood tend to be eventually more native-like in their perception of L2 speech than those who start to learn an L2 in adulthood, provided substantial exposure to the target language is present.

The afore-mentioned findings, however, do not agree with a body of research carried out among Catalan-Spanish bilinguals. Sebastián-Gallés and Soto-Faraco (1999) found that highly proficient Spanish-dominant bilinguals, who had been exposed to Catalan between the ages of three and four, and only to Spanish before this age, performed worse than Catalan-dominant bilinguals exposed to Catalan from birth. In a gating task, the Spanish-dominant bilinguals needed more information to correctly label phonemic contrasts existing in Catalan but not in Spanish. Bosch, Costa and Sebastián-Gallés (2000) reported the same results regarding the discrimination of Catalan /e/ and /ɛ/ in a comparable population of Catalan-Spanish bilinguals. The authors of both studies interpreted the findings as providing support for the hypothesis that native language shapes the perceptual space of bilinguals at early stages of development, in such a way that it will irreversibly determine the perception of non-native segments, even if there is extensive and early exposure to the sound system of the L2. However, as Højen and Flege (2006) noted, the Catalan-Spanish bilinguals' performance may have been related to their language dominance and/or exposure to foreign-accented L2 input, rather than to loss of plasticity in L2 speech perception. Basing their arguments on their own research with native Spanish speakers, Højen and Flege showed that most early learners in their study were able to discriminate three difficult English vowel contrasts to native-like levels. These learners rated their

ability in the L2 higher than in the L1, were characterized by an intensive exposure to English from the age of three years and by a frequent use of the language, especially during their first years of English acquisition.

To summarize, prior as well as current learning appear jointly to determine how early learners, as opposed to late learners, perceive non-native sounds. Child/ early L2 learners commonly find themselves in a learning scenario in which they lack a long-lasting exposure to and experience with processing an L1, on the one hand, and enjoy intensive and massive exposure to the target language, on the other. Their perceptual abilities in an L2 are therefore likely to develop more than those of adult/ late L2 learners, although not necessarily to native-like levels.

4.2. Age effects on L2 vowel production

Significant early-late differences have also been observed for the production of L2 vowels. For example, Flege, MacKay and Meador (1999) examined intelligibility scores obtained for ten English vowel sounds produced by Italian speakers differing in age of arrival in Canada. The late group (mean AOA=19) was significantly less accurate in producing six of the tested vowels than was a control group of native speakers. The intelligibility scores obtained for a mid group (mean AOA=14) differed from that of the native speakers for one vowel production. Two early groups (mean AOA=7) performed with native-like ability regardless of their (lack of) continuous use of the native language.

These findings were further explored in a follow-up study employing a more comprehensive methodology design. Using listeners' ratings of degree of goodness, rather than intelligibility scores, including familiar English words as well as non-words, and examining a wider range of English vowels, Piske *et al.* (2002) corroborated the findings of the Flege, MacKay and Meador (1999) study in all but one respect. Those early starters who continued to use their L1 frequently differed from the native speakers in their production of some of the tested English vowels, most of which were confined to the non-word condition. The authors argued that

the production errors of the Italian speakers showed L1 orthography influence and that they may have been more prominent in frequent users of the L1, since their native lexicon might have been activated more strongly and extensively. In yet another study, this time one that was developmental in design, Tsukada *et al.* (2005) demonstrated that native Korean children performed more accurately than did native Korean adults in a picture naming task after both three and five years of residence in the L2-speaking country. The Korean children's performance was shown to be comparable to that of age-matched English children, both in terms of intelligibility of the tested vowels and the magnitude of formant frequency differences between English /ɛ/-/æ/ and /ʌ/-/ɑ/ sounds. However, Baker *et al.* (2002) reported that native Korean children with less than one year of residence in the target language country produced L2 vowels less accurately than did age-matched native English-speaking children. Together, these findings suggest that differences between native and non-native children in terms of their production abilities may largely disappear after about three years of residence in the L2-speaking country. The present study examines whether this may hold true also for Polish children learning L2 vowels in a migrant setting in Ireland.

To conclude, previous research has demonstrated that late bilinguals generally perceive and produce L2 vowels less like native speakers, and also less like early bilinguals. In turn, early bilinguals are likely to be developing more rapidly and more native-like in their perception and production of L2 vowels. There is evidence, however, that continuous use of the native language influences how L2 sounds are perceived and pronounced, even in early bilinguals. These findings would suggest that the development of L2 speech perception and production may be affected by age-related changes in the way L1 and L2 sound systems interact in bilingual learners.

Although discussed separately so far, it is conceivable that there is a close relationship between the development of L2 speech perception and production skills

in L2 learners. Intuitively, one would believe that without accurate perception, accurate production is unlikely. Indeed, implicit in the SLM (1995) discussed earlier is the notion that the ability to perceive differences between similar L2 sounds, and/or between L2 and L1 sounds aids accurate L2 sound production. The following section thus discusses previous research into the relation between L2 speech perception and production, as documented for learners varying across age of arrival in the target language country.

4.3. The relationship between L2 speech perception and production

The most widely supported hypothesis in L2 speech learning research, as well as in L2 phonetic training, posits that accurate perception is an important prerequisite for accurate production (e.g. Bradlow *et al.,* 1999; Escudero, 2005; Flege, 1999; Hewings, 2007; Rochet, 1995). Other research has suggested, however, that accurate production may precede accurate perception of non-native sounds (Sheldon and Strange, 1982), and that the perception-production link may be of a more complex nature depending on a variety of factors.

For example, Baker and Trofimowich (2006) examined Korean early and late learners of English with less than one year, with three years and with ten years of residence in the U.S. In the first set of experiments, the authors found that the perceptuo-motor skills were developing simultaneously in all the tested groups. In other words, those learners who perceived L2 vowels accurately were also those who produced the vowels accurately, and vice versa. Furthermore, in-between group analyses revealed that only the early starters performed native-like in both domains. On the basis of these results, Baker and Trofimowich argued that "perception and production abilities are related to each other and to a number of individual-difference factors" (p. 240). The next stage of the data analysis, in which the early and late L2 learners were regrouped according to their L2 production, indicated that while the intermediate and low English group did not differ significantly in their perception of L2 vowels, intermediate L2 learners varied widely

in their perceptual performance. Some reached a score comparable to that of a control group of native English speakers; in other words, these L2 learners' perception abilities surpassed their production abilities. Yet, some learners in the group attained better accuracy in production than perception. In a further examination of the data, self-perception (the ability to perceive one's own speech accurately) was, in fact, found to affect their L2 production abilities. Taken together, the findings of the study were interpreted as supporting the claim that there is a perceptual basis for accurate L2 production, and that early learners are better able to translate accurate perception into accurate production than late learners.

Two more studies by Baker *et al.* (2002, 2008) examined the development of L2 speech perception and production in groups of L2 child and adult learners differing across L2 experience. In both studies, inexperienced child L2 learners were found to be comparable in their perception of L2 vowels to inexperienced adult L2 learners; however, in terms of production, children tended to outperform adults. Thus, in the initial stages of L2 speech learning, children's production superseded their perception abilities in these studies. After about nine years of stay in the target language country, the children attained native-like accuracy in their both perception and production of English vowels, however. The authors speculated that these finding may be related to the children's greater ability to perceive differences between L1 and L2 sounds, which may be a result of the way L1 and L2 phonetic systems interact in child and adult L2 learners:

> [A]n individual's age at the time of exposure to the L2 appears to determine the degree to which these abilities [cross-language phonetic similarity perception and L2 production] are related. In younger learners, they are related more closely, allowing these learners to perceive L1-L2 differences and to accurately produce L2 sounds, particularly those that are not present in the L1 sounds inventory ... In older learners, producing L2 sounds and perceiving cross-language phonetic differences represent abilities that are associated loosely (if at all) (Baker *et al.*, 2008; p.337).

The results of the studies just discussed suggest that the relationship between perception and production abilities of diverse L2 learners may not be straightforward. In addition, as Tsukada *et al.* (2005) pointed out, tests examining L2 segmental perception and production are in principle incommensurable, posing presumably different levels of performance difficulty for both adult and child L2 learners. To relate the development of the two skills in a valid manner may therefore be difficult.

In any case, there is strong evidence indicating that, in naturalistic learning environments, child L2 learners are rapid in the development of L2 speech production skills, and eventually are more native-like also in their L2 speech perception than is usually the case for adult L2 learners. In the next section, the hypotheses presented most frequently in seeking to explain why children commonly outperform adults in L2 acquisition are reviewed.

4.4. Hypotheses regarding causes of age effects in L2 acquisition

In spite of the well-attested age effects in L2 speech learning, as discussed earlier, the best explanation for these effects remains a matter of controversy. Three accounts have been most frequently put forth in previous L2 acquisition research: the maturational account, the L1-L2 interaction account, and the environmental account. As will be demonstrated in the course of the discussion below, each of the accounts has some predictive value, but none, individually, seems to best explain all the evidence concerned.

4.4.1. The maturational account has often been discussed in relation to the existence of a critical or sensitive[3] period for language learning, as formulated by the Critical Period Hypothesis (henceforth CPH). Although there exists a vast amount of variation in the way the concept has been understood in the relevant research, the common point that reoccurs in all definitions of the CPH is that

[3] To distinguish between periods of a sudden decline and those of a more gradual decline, some researchers use the term "sensitive period" for the letter. For discussion, see Eubank and Gregg (1999) and Munro and Mann (2005).

"learning during a critical period is assured, similar across individuals, normatively described, [while] ... learning outside of the critical period is different in both form and success, especially in that it would be less certain and more erratic in its outcomes" (Bialystok and Hakuta, 1999; p. 164).

Lenneberg (1967) was among the first to propose that puberty was the cut-off age for full (first) language acquisition, since by this age, he claimed, lateralization of language functions to the dominant left cerebral hemisphere of the brain is complete. With respect to L2 acquisition, he asserted that "automatic acquisition from mere exposure to a given language seems to disappear after this age, and foreign languages have to be taught and learned through a conscious and labored effort. Foreign accents cannot be overcome easily after puberty" (p.176).

In a similar vein, Seliger (1978) argued that besides the process of lateralization, there is also one of localization within the dominant brain hemisphere. As this process continues, phonetic/phonological functions are expected to be localized first, and therefore the ability to master a native accent in a foreign language is lost earliest. He situated that loss "not much beyond the onset of puberty in most cases" (Seliger, 1978; p. 16). Taking a different tack, Scovel (1988) claimed that pronunciation differs from other language domains fundamentally, in that it has a "neuromuscular basis". He predicted that those L2 learners who start to learn an L2 at around the age of 12 and later will never be able to "pass themselves off as native speakers phonologically" (p.185; cf. Scovel, 2000). Finally, a number of studies have reported evidence for the existence of a critical period for L2 morphology and syntax (DeKeyser, 2000; DeKeyser, Alfi-Shabtay and Ravid, 2010; Johnson and Newport, 1989; Patkowski, 1980).

Arguably, the most influential study to date relating to the CPH in L2 acquisition is that by Johnson and Newport (1989), investigating acquisition of English morpho-syntax by 46 Korean and Chinese learners. These learners arrived in the U.S. between the ages of 3 and 39 years, and lived in the country for about

10 years. In a grammatical judgement test, those learners who arrived before the age of 7 were shown to perform with native-like ability. In contrast, for those who arrived between 8 and 15 years of age, a linear decline in performance was found (r=-.87). Most importantly, for those who arrived after the age of 17 years, the distribution of performance was non-linear and highly variable (r=-.16); none of the late arrivals performed within the native range of scores. The authors concluded from these results that there is a maturationally determined critical period for L2 acquisition, which closes after puberty, and that "for adults, later age of acquisition determines that one will not become native or near-native in a language" (p.81).

Prima facie, the CPH represents a powerful explanation for age effects in L2 acquisition. Since its first formulation in 1960s, however, the notion has become a source of great deal of disagreement, even among its own proponents. For instance, there is little agreement about an exact offset (as well as onset) of such a critical period for L2 acquisition. While some researchers claim that this sensitivity may begin to decline as early as age seven (Johnson and Newport, 1989; Long, 1990), others claim that successful L2 acquisition may go on up to puberty and perhaps beyond (Oyama, 1976; Patkowski, 1980) before a decline in language acquisition ability occurs. Some researchers have made distinct timing claims for specific areas of linguistic performance, suggesting that "multiple critical periods" may be at play during L2 acquisition (cf. Long, 1990; Seliger, 1978). In addition, different explanations for the critical period(s) have been offered, ranging from neurobiological, cognitive to affective (for a comprehensive review, see Singleton and Ryan, 2004). As Singleton (2005) rightly pointed out, the CPH must be questioned as a plausible scientific hypothesis, if the only note that is possible make in this regard is that "[f]or some reason, the language acquiring capacity, or some aspect or aspects thereof, is operative only for a maturational period which ends some time between perinatality and puberty" (p.280). In addition, the existence of

a critical or sensitive period for L2 acquisition has been questioned due to the abundance of conflicting evidence, discussed in greater detail below.

First, the most powerful counter-evidence seems to come from studies that have shown that there exist L2 learners who can display native-like abilities in the target language despite starting to learn the language after the purported critical period. For instance, Bongaerts, Mennen and Van der Slick (2000) documented that a number of late Dutch learners of English were able to pronounce English to levels indistinguishable from native speakers. Similarly, a case study by Ioup *et al.* (1994) reported successful acquisition of Egyptian Arabic as an L2 by two adult native speakers of English. The performance of both learners was close to native speaker norms on a variety of tasks, including speech production tasks, grammaticality judgements, translation tasks, anaphoric interpretation tasks, and an accent recognition task. In terms of L2 segmental acquisition, Flege, MacKay and Meador (1999) demonstrated that some late L2 learners are able to produce and perceive non-native vowels within a native-like range.[4]

Second, researchers arguing against a critical/sensitive period point out that if such a period exists, no other factors but the process of maturation should affect the outcome of L2 learning. In other words, if there is a critical/sensitive period, it should be found for all L2 learners alike, regardless, for example, of their native language background or years of education in the target language country. However, Birdsong and Molis (2001), who replicated the famous study by Johnson and Newport (1989) with Spanish learners of English, found no significant decline of language abilities for participants aged 3 to 15 years, although they did find age effects for those who learned English after the age of 17. Birdsong and Molis argued that the Spanish participants in their study should have performed at an equally low level as the Korean and Chinese participants in Johnson and Newport's study, if

[4] A cautionary note has been raised against this compelling evidence on methodological grounds, in that some studies on ultimate attainment in L2 acquisition tend to employ tasks of a too limited sensitivity to determine what constitutes native-like abilities (cf. Bialystok, 1997; Abrahamsson and Hyltenstam, 2009; Moyer, 2008).

indeed a critical period for L2 acquisition was to be corroborated. In addition, Flege, Yeni-Komshian and Liu (1999) demonstrated that age of arrival effects may disappear when variables such as years of education conducted in the L2, length of residence in the L2-speaking country, and amount of L2/L1 use were controlled. In their study, two groups of early and late L2 learners (10 and 17 years of age upon arrival, respectively) were not found to significantly differ in grammaticality judgement scores when matched on the variables mentioned above.

Third, it has been argued that, if a critical period does exist, then after the proposed critical point in time has passed, L2 performance should no longer be correlated with age and should stay at approximately the same level. Johnson and Newport (1989) claimed that there was no correlation with age and grammaticality scores after the age of 15 years in their participants. Birdsong and Molis (2001), again, refute this finding on the basis of results of their own study. They found that age at the time of L2 acquisition did correlate with late learners' grammatical accuracy until after adulthood (r=-.69, $p<.01$). In addition, a re-examination of the Johnson and Newport findings by Bialystok and Hakuta (1994) revealed that, when the learners were regrouped, age effects in the Johnson and Newport study actually extended for "post-critical period" learners as well. Similarly, Flege, Munro and MacKay (1995) found that the overall degree of perceived foreign accent in the production of English sentences by 240 Italian-English bilinguals increased *linearly* as a function of age at which they first began learning English in Canada (between 2 and 23 years of age). No marked discontinuity indicating an end of a critical period at puberty or any other age was found in that study (see Figure 2.3. below).

Finally, the critical period hypothesis fails to explain cases of some early starters who do not perform like native speakers in their L2, despite acquiring the target language in an immersion setting within the purported critical period. Flege, Frieda and Nozawa (1997) examined foreign accent ratings given to two groups of early Italian-English bilinguals, who were matched for average AOA (mean=6

years), but differed in the extent of their native language use. Both groups of early bilinguals spoke with a detectable foreign accent. When a separate analysis was carried out for subjects with the lowest AOA in the study (mean=3.2 years), even this group of L2 learners was found to speak English with a foreign accent. Similarly, Thompson (1991) reported that Russian-born migrants who arrived in the U.S. between the ages of 4 and 10 were judged to speak with a slight foreign accent.

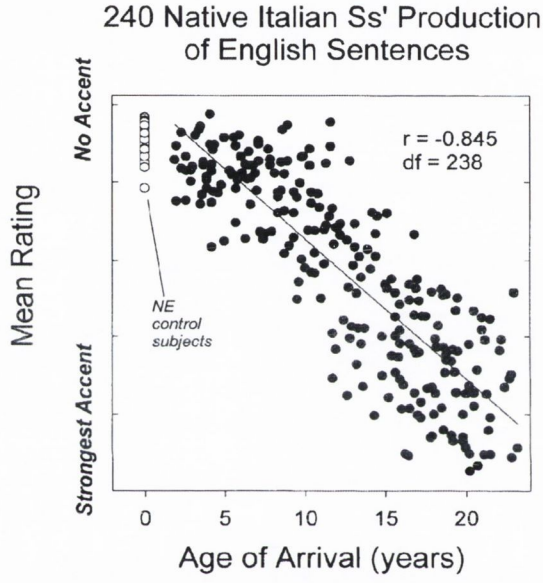

Figure 2.3. Degree of foreign accent of Italian-English bilinguals (reproduced from Flege, Munro and MacKay, 1995)

It may also be worth mentioning a number of short-term studies of naturalistic L2 learning, which documented that adults and older children may actually be superior in some aspects of L2 learning. Such evidence does not seem to be consonant with some of the predictions of the CPH either. For example, Fathman (1975) examined 200 children between the ages of 6 and 15 years, who learned English as an L2 in American public schools, and found that older learners scored higher on syntax and morphology tests, whereas younger learners received higher ratings in phonology. The oft-cited studies by Snow and Hoefnagel-Höhle (1977; 1978) also showed that older L2 learners can enjoy an *initial advantage* over younger ones on a number of different language tasks, suggesting that adults'

and older children's *rate* of second language acquisition can initially be faster than that of young children. The young children in the Snow and Hoefnagel-Höhle studies, nevertheless, caught up with adults in about one year, a result which in the end complies with the claim that young L2 learners, in a long-term perspective, tend to be globally more successful learners (Krashen *et al.,* 1982; Singleton and Lengyel, 1995; Singleton and Ryan, 2004).

To summarize, none of the many versions of the CPH appear to be consistent with the now established evidence that, in general, the capacity for L2 acquisition follows a linear pattern as a function of age of L2 learning. Such evidence, however, is not to be interpreted as indicating that maturation may not be at work in some fashion in the process of L2 acquisition at all (Birdsong, 1999; 2006; Flege and MacKay, 2010).

4.4.2. The L1-L2 interaction account offers another possible explanation of age effects in L2 acquisition. This perspective posits that the two languages spoken by a bilingual inevitably interact with one another. The degree and direction of such an L1-L2 interaction will, however, differ for child and adult L2 learners, since children's native language is still developing and therefore is likely to exert less influence on their L2 acquisition (Flege, 1995, 1999, 2007; Grosjean, 1982, 2001). This view is in line with the notion that 'earlier is better in the long run' in terms of L2 acquisition; however, it focuses on the role of native language development and its increasing role in how additional languages are acquired, rather than on the role of maturational effects in L2 acquisition.

The interaction hypothesis has been tested in a number of studies motivated by the SLM (1995) introduced earlier. For example, Baker and Trofimowich (2005) examined L2 production of vowel sounds in early and late Korean bilinguals, who further differed in the amount of L2 experience. The results of the study indicated that early bilinguals' productions manifested a bidirectional L1-L2 influence, while late bilinguals' productions showed a unidirectional influence of the L1 on the L2.

The degree and direction of the influence was further affected by the level of similarity between L1 and L2 sounds, and the bilinguals' length of exposure to the target language; early bilinguals, as opposed to late bilinguals, were shown to produce acoustically distinct L1 and L2 vowel sounds, both initially and after a prolonged stay in the L2-speaking country. The authors interpreted the results as evidence that L1 and L2 sound systems interact differently in child and adult L2 learners.

The interaction hypothesis is based on the assumption that children's native language sound system differs crucially from that of adults. As discussed earlier, research into the development of L1 speech has indicated that in the first months of life, infants are endowed with universal discrimination abilities, which, nevertheless, decline as early as one year of age[5] (Best, 1995; Polka and Werker, 1994; Jusczyk, 1997). The important point here is, however, that attunement to the native language sounds has been found to be gradual, i.e. that L1 sound categories are slowly refined throughout childhood and perhaps into adolescence. For instance, Nittrouer and Miller (1997) showed that four-year-old children categorized fricative–vowel syllables less similarly to adults than seven-year-olds did. Hazan and Barrett (2000) found a similar developmental increase between the ages of 6 and 12, concluding that by 12 years, and perhaps by age 17, children still do not categorize consonant sounds as consistently as adults. Johnson (2000) showed that children and adolescents do not identify native consonants and vowels in various noise conditions as adults do. Taken together, these findings suggest that children's and even adolescents' representations of native sounds are indeed different from those of adults'.

[5] It may be interesting to note that the perceptual decline has been found for vowels earlier than for consonants—6 to 8 months of age and 10 to 12 months of age, respectively. Polka and Werker (1994) hypothesized that the earlier experience effect on vowel perception may be triggered by the fact that vowels carry affective prosodic information and are thus more salient at an earlier point in the infant's development.

One consequence of fully developed L1 categories may be that adults will be less likely to perceive differences between L1 and L2 sounds, and will therefore perceive and produce non-native sounds under a greater influence of their native language. Children, in turn, may be less likely to perceptually relate L2 and L1 sounds, because their evolving L1 sound system does not yet have a strong assimilative power on the perception of L2 sounds. Consequently, they will be more likely to perceive and produce the L2 accurately.

The interaction hypothesis offers a testable alternative account for child-adult differences in L2 phonological acquisition. The present study was designed to test the hypothesis, i.e. this study seeks to determine if the perceived dissimilarity between L1 and L2 sounds indeed decreases as L1 categories develop in L2 learners, and whether such changes predict accuracy of L2 segmental perception and/or production.

4.4.3. The environmental account is based on evidence that early learners are typically exposed to a richer L2 environment, and for longer, than are late learners, hence their higher ultimate attainment in L2 ability. For example, in a longitudinal study, Jia and Aaronson (2003) examined changes in L2 as well as L1 proficiency, language preferences, and language environments in a group of ten Chinese children and adolescents residing in the U.S. The results of the study showed that children aged nine or lower upon arrival switched their language preferences from L1 to L2 within the first year. They were found to be exposed to a significantly richer L2 input than L1 environment, and became eventually more proficient in their L2 than their L1 (as measured by a grammaticality judgment task and a translation task). The richer L2 input in the very young participants was associated with significantly greater L2 use with L2-speaking peers, both at school and in their free time, and frequent interactions with the host culture. In contrast, children aged 12 and above in the study tended to gravitate towards L1-speaking

situations and remained dominant in their L1 across the 3 years when the study was conducted (see Figure 2.4.).

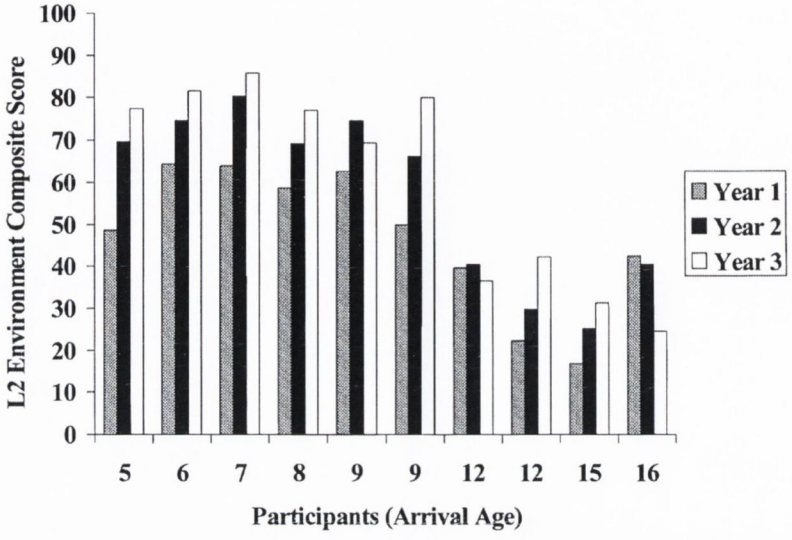

Figure 2.4. The L2 environment composite scores (average of percentage scores of number of predominantly L2-speaking friends, books read in L2, hours of L2 TV watching, and L2 spoken at home) for each participant (reproduced from Jia and Aaronson's study, 2003)

The difference in quality and quantity of L2 input among child and adult L2 learners may indeed have important effects. As Flege (1988) argued, children may develop a greater sense of confidence and identity in L2 than adults, eventually leading them to a switch in language dominance and to higher proficiency in the L2. They may also understand more of the L2 speech addressed to them, leading to a quantitative difference in intake. Moreover, L2 input may be richer in sensory associations for children than adults, making the L2 easier to store and activate.

To conclude, the environmental account is equally appealing in the discussion on why children are usually more successful in learning an L2 than are adults. However, it is not clear at present *to what extent* input differences contribute to age effects in L2 acquisition. The next section of this chapter presents and discusses theory and findings from previous research on the theme. Specifically, the role of L2 input in the development of L2 vowel perception and production among child and adult learners is discussed.

5. Experience in second language speech learning

As the discussion outlined above has demonstrated, "age" in L2 acquisition presents a conundrum for L2 research, due to the wide range of variables conflated with the factor, including neurological maturation, state of the development of L1 phonetic system, language dominance, frequency of L2 and/or L1 use, and quality of L2 input. In addition, L2 input itself is typically interwoven with a number of experiential and socio-psychological factors hypothesized to affect L2 acquisition, such as the learner's orientation towards the target language and culture (Moyer, 2008). Not surprisingly then, previous research has been inconclusive about the extent to which L2 experience contributes to age effects in the acquisition of L2 speech.

Previous research has traditionally indexed L2 experience by length of residence in the target language country (LOR), a measure which presumably indicates the learners' first substantial exposure to a variety of authentic and meaningful L2 uses. However, great differences in L2 (phonological) acquisition between immigrants of a comparable LOR but of differing language contact or opportunities for language use have been noted. As Moyer (2008) argued, mere exposure to the target language is simply not enough, even for early starters, as input *and* learner orientation work together, and affect L2 attainment. Moyer therefore called for more qualitative and context-bound analyses of L2 experience if a better understanding of the impact of the many facets of L2 experience on L2 acquisition is to be gained.

Another difficulty with examining data on L2 learning experience lies in the fact that such data are commonly received from participants' self-reports in which frequency of L2 use in various domains is estimated, rather than measured, and therefore may be subject to error (Flege, 2008). Some of the threats to validity in this type of measurement can possibly be minimized, for example, by administering questionnaires examining L2 learners' contact with their languages in a confidential

and supportive manner, by including related closed and open questions, and by supporting the collection of such data with follow-up interviews. Such an approach was employed in the present study.

Finally, at an individual level, L2 experience may constantly change, showing periods of massive native speaker input, followed or accompanied by exposure to input from non-native speakers of the L2, and perhaps replaced by a period of sole L1 exposure for some time. To examine the effect of L2 experience on L2 acquisition in a reliable manner may thus be difficult. Bearing all these limitations in mind, let us now turn to a review of existing studies examining the role of L2 experience in L2 speech learning of diverse learners.

5.1. Experience effects on L2 speech perception and production

Current models of L2 speech learning predict that increased experience with the target language does facilitate L2 learners' ability to perceive and produce L2 speech more accurately, but that learning some L2 sounds may be especially impervious to L2 experience (Best, 1995; Flege, 1995). For instance, Bohn and Flege (1990) found experience effects on German speakers' discrimination of the English /ɛ/-/æ/ contrast, the latter vowel having no counterpart in their L1. Those learners who had lived in the U.S. for about 7.5 years performed more like native speakers in the perception of this L2 pair than did those who were recent arrivals. However, no such effect was found for contrasts that involved similar sounds in the L2 and L1 concerned. This finding was later corroborated for L2 vowel perception and production in German, Spanish, Mandarin and Korean speakers (Flege, Bohn and Jang, 1997). In a longitudinal study, Munro and Derwing (2008) reported improved intelligibility scores for the production of only some English vowels in adults of Mandarin and Slavic backgrounds. The largest amount of progress was found to have occurred during the first six months of the participants' stay in Canada. The authors speculated that, in the first year of exposure to spoken English, the learners may have reached an upper limit on acquisition of those L2

vowels that do not exist phonemically in their native language, and that further experience with the L2 may have a minimal effect on the production of similar L2 sounds by adult learners, unless pedagogical intervention is provided.

Baker *et al.* (2002) compared the development of L2 speech learning among Korean children and adults, who lived in the U.S. for one and nine years. The children were found to benefit from the longer stay in the U.S. significantly more than the adults, as their performance was eventually judged to be native-like for all the tested vowel sounds. The Korean adults' perception and production abilities in the L2 also improved with time; however, only for sounds that were initially perceived as non-confusable.

These findings suggest that experience effects in a naturalistic learning environment are likely to be more prominent for some L2 segments, and more apparent for child than for adult L2 learners, who are likely to be exposed to a greater variety of native-speaker input for longer periods of time on the one hand, and less frequent L1 use, on the other. A recent re-analysis of Flege's large-scale studies with Italian and Korean immigrants in North America confirmed that good L2 pronunciation is indeed associated with early age of arrival in the target language country, a lengthy residence in the country, frequent use of the L2 with native speakers, and poor proficiency in the native language (Flege, 2008). It is of interest in the present study to examine whether the specific migrant experience of the Polish children and adults in Ireland, for whom frequent L1 contact is maintained in their everyday life in Ireland, might represent a different constellation for their L2 speech learning.

It might also be that, due to the more intensive exposure to the target language, child L2 learners might be more motivated to use the second language frequently and accurately. As Moyer (2008) noted, it is inevitable that experiential *and* affective factors (interwoven with age of L2 learning) work together in L2 phonological acquisition. The role of social and psychological factors in L2

acquisition is therefore discussed in the next section. The discussion is set within the Dynamic System Theory, a perspective that has recently been identified in L2 research as offering useful conceptual vocabulary to describe such a complex endeavour as learning a language represents.

5.2. Social and psychological factors in L2 acquisition

Learning a new language is necessarily situated in specific personal, social, cultural, and historical contexts. It is conceivable that, especially in an (im)migrant setting, such contexts may be highly emotion-tied and changeable. As Ushioda (2009) argues, a 'person-in-context relational view' may, in fact, be the only suitable approach to reflect upon the complexities of the L2 learner's experience. She calls for:

> ... a focus on the agency of the individual person as a thinking, feeling human being, with an identity, a personality, a unique history and background, a person with goals, motives and intention; a focus on the interaction between this self-reflective intentional agent, and the fluid and complex system of social relations, activities, experiences and multiple micro- and macro-contexts in which the person is embedded, moves, and is inherently part of (p. 220).

This view challenges a more traditional approach to investigating L2 acquisition and individual characteristics of the L2 learner as stable and context-free traits. As Dörnyei (2009a) argued, motivation for learning an L2, attitudes towards the target language and culture, anxiety, and other learner characteristics are fluid and context-dependent; even genetically inherited characteristics cannot be generalized across situations and time, since they are 'multicomponential' in nature and interact with environmental factors.

Such a perspective is in line with the *Dynamic System Theory (DST)*, which has recently brought a fresh optique to the way L2 development can be understood and researched. It conceives of language as a natural system that is dynamic, complex, non-linear, unpredictable, sensitive to initial conditions, open, self-organizing, feedback-sensitive, and with a tendency to settle in 'attractor states'

(De Bot, 2008; Jessner, 2008; Larsen-Freeman, 2007). In this perspective, no seemingly stable L2 learner characteristics are absolute, but rather, are a result of an internal self-organization settling into a preferred attractor state. For instance, L1 perceptual targets can be seen as such 'attractors' in L2 learners' phonology. However, given the availability of such 'resources' as motivation and attitudes towards the target language, L2 input and feedback, these attractors may be weakened over time, while others (e.g. target-like L2 production) may be strengthened. Yet, no attractor state will represent an end state of language development in this perspective, as resources themselves interact, and are often limited.

Recent research into L2 motivation in particular has become inspired by the DST perspective. According to Dörnyei's theory of the *L2 Motivational Self System* (2005), motives for L2 learning should be seen as dynamically evolving, bound up with the learner's perception of self and interactions with the environment. Drawing on psychological research into 'possible selves' (Markus and Nurius, 1986; Higgins, 1987), previous L2 motivation research (Gardner, 1985; 2001; Noels, 2009), and the rather specific situation of today's learners of English who might no longer associate English just with Anglophone countries (Cootzee-Van Rooy, 2006; Lamb, 2004; Ryan, 2009; Ushioda, 2006), Dörnyei re-conceptualizes the key construct of integrativeness in L2 motivation. He suggests that integrative orientation is related to the process of identification within the individual's self, rather than to identification with another cultural community, and that the self-concept is composed of three dynamic dimensions: the ideal L2 self, the ought-to L2 self, and the L2 learning experience (Dörnyei, 2005).

The ideal L2 self captures the learner's image of him/herself in the future. For instance, Polish migrants in Ireland may like to envisage themselves as fluent speakers of English, communicating efficiently with both native and non-native speakers of English in international contexts. This dimension has a promotion focus

(Higgins, 1998), and traditional integrative and internalized instrumental motives would belong to this component. *The ought-to L2 self* is related to the learner's understanding of his/her responsibilities to meet the expectations of significant others or external authorities, and to avoid possible negative outcomes. For example, a vision of being praised for achieving a good grade in English by a Polish child attending an English-medium school in Ireland would represent such a case. This component has a prevention focus (Higgins, 1998), and corresponds to the more extrinsic types of instrumental motive. The third dimension, *L2 learning experience* concerns previous learning experience and its interaction with the present learning environment. Dörnyei includes this component mainly to reflect on the specific learning experience of formal L2 learners and to assess how the classroom environment can aid L2 motivation; however, it is reasonable to suppose that naturalistic learning experience will also exert strong effects on L2 learners' motivation towards the target language. As Norton (2000) demonstrated, immigrants' investment in the language can be affected significantly by the practices of the target linguistic community. Some Polish adults in Ireland, for instance, may feel constrained in their attempts to speak English with their native speaking workmates, because they might have felt disrespected in a work position that is below their level of qualifications and/or because of lack of English skills. Others may feel quite encouraged by success and support when making themselves understood in real life situations in Ireland, as opposed to the feelings of frustration they may have had after many years of learning English in a formal setting in Poland. This experience may, in return, feed into their ideal L2 selves as fluent L2 speakers of English in the context of international communication. It is Dörnyei's (2009a) belief that:

> ...the existence of any one of these attractor basins alone is sufficient to provide the necessary modulating and co-ordinating influence on the direction, vigour and persistence of behaviour to reach at least a working knowledge of the L2, but if the three systems are in harmony, that will have an increased, cumulative effect (p.218).

Dörnyei (2009b) further enlists several conditions that must be met for the L2 selves to have a motivational impact. One such condition is that the L2 learner must have a roadmap of sub-goals and strategies to approximate the ideal self. For example, learners with the ambition to pass for a native speaker may require systematic feedback on their L2 pronunciation. Research conducted by Bongaerts, Mennen and Van der Slick (2000) and Moyer (1999) on native-like attainment in L2 phonology by late starters indeed found that exceptional L2 phonological ability is often related to the learner's experience with formal phonetic training and high levels of professional motivation to sound native-like. Also, the learner's vision must regularly be nourished and emotion-tied via, for instance, regular contact with native speaking friends. Finally, awareness about negative consequences of failing to achieve the desired L2 self seems to help learners to continue in their attempts to learn the target language. This can be embodied, for example, in some Polish children's fear of losing the positive view that Irish teachers often hold towards them as hard-working and talented at languages, or in their fear of disappointing their parents.

One important question, in relation to the present study, is to what extent the L2 Motivational Self System may apply to all L2 learners, including children. It has been suggested that young children may have difficulties with discerning multiple perspectives on the self, especially as regards their perception of what significant others expect from them (Zentner and Renaud, 2007). Oyserman *et al.* (2004) have shown, however, that even young children can describe wishes about themselves, notably short-term goals, and that those children who are able to accompany these wishes with strategies for attaining them are likely to be successful in pursuing their ideal L2 selves. The way children and teenagers see themselves as future language users will change quite dramatically as their identities develop, and thus the impact of the ideal L2 selves on motivated L2 learning is likely to vary significantly in these age groups (Czisér and Kormos,

2009; Lamb, 2004). MacIntyre, Mackinnon and Clément (2009) raise other important questions in this regard, such as reliability of measurement of possible selves and the extent to which possible selves can indeed be distinguished from pure dreams that are not likely to trigger the desired change in L2 performance (cf. a collection of L2 self-studies edited by Dörnyei and Ushioda, 2009).

To summarize, the L2 Motivational Self System is conceptualized as a dynamic system of complex interactions with certain attractor states in play, but subject to alteration as goals, attitudes and potentials in respect of the future change. By using the conceptual vocabulary of the DST perspective, some new insights are offered into the intricacies of motivated L2 learning. Although the present study was not designed within the DST, Dörnyei's concept of the L2 self was incorporated into the examination of the Polish learners' attitudes towards English, providing a suitable theoretical framework for the investigation of the specific situation of the Polish migrants living in Ireland at the time of the study.

In the next section, a summary of previous research relevant to the present study is provided, followed by formulations of motivation and main hypotheses for the present research.

6. Summary of prior research

The starting point in current L2 speech research often involves evaluation of similarity between L1 and L2 sound systems. Whereas it is generally assumed that the greater the linguistic distance between the sounds of the languages, the more difficult it will be for the learner to acquire the new sounds, this is not necessarily so. Past research has actually shown that the more similar an L2 sound is to an L1 counterpart, the more difficult it is for the L2 learner to detect the subtle phonetic differences between the two sounds and to perceive and produce the L2 sound accurately (Best, 1995; Flege, 1995). What the same research does not agree on,

however, is how to measure the perceived degree of similarity between L1 and L2 sounds. One way of doing so is to have L2 learners match L2 sounds onto respective L1 sound categories by using key words, and to indicate the perceptual match via goodness-of-fit ratings (Guion *et al.,* 2000; Strange, 2007).

The ability to learn similar as well as new L2 sounds ultimately depends on an accurate assessment of the auditory properties of L2 sounds, and a translation of this information into production. Child L2 learners appear to be more successful in this ability because their L1 sound system is still developing and as such presumably exerts less influence on their L2 speech learning (Flege, 1995; Baker *et al.,* 2008). However, this perspective on age-related differences in L2 speech learning is not necessarily the only one. Until recently, research in this area was guided by predictions stemming from studies into a critical period in L2 phonological acquisition. In this view, the relative success of child L2 learners, as opposed to adult L2 learners, is related to children's exposure to the target forms at an ideal moment of their neuro-linguistic, cognitive and/or affective development (DeKeyser, 2000; Scovel, 2000; Schumann, 1975). Still another avenue of research has turned its attention to an examination of the role of L2 input in L2 speech learning. Such studies point to the fact that children are commonly exposed to massive and varied native-speaker input, which, in turn, aids their development of accurate L2 perception and production (Jia *et al.,* 2006). Also, mediating factors, such as motivation for sounding native-like and formal training have been found to aid successful L2 phonological acquisition (Moyer, 1999).

An interplay of factors thus seems to jointly determine how accurately L2 sounds are perceived and produced, with the most significant such factors being, as established by previous research, age of arrival in the target language country, native language phonology, and (quality and quantity of) L2 experience. It seems impossible to disentangle the influence of each of these factors on L2 speech

learning, as they all form a part of a dynamically evolving language system. As Dörnyei (2009a) summarizes aptly:

> ...the reason why the understanding of age effects appears to defy efforts to produce unambiguous principles and tenets is that we are facing a complex system with multiple powerful attractors that can form a number of compelling combinations: neurobiological and cognitive processes take place in the brain; social trajectories are activated by different ages of arrival in immigrant situations; and strong interferences are to be expected both from our L1 system and our personal characteristics (p.264).

7. Motivation for the present study

The present study was motivated by the fundamental hypothesis of Flege's Speech Learning Model (1995) on age-related differences in L2 phonological acquisition. The hypothesis proposes that child learners will be less likely to identify L2 sounds as members of L1 sound categories. The reason for this tendency in child L2 learners is that their native language categories are not yet established, and therefore, will act as weaker attractors of L2 sounds. Consequently, children are predicted to be more successful in forming new categories for L2 sounds, and in accurate L2 sound perception and production than adult L2 learners. The main purpose of this current study, therefore, was to determine the effect of cross-language phonetic similarity perception on L2 speech learning.

In addition, the current study expanded on two previous studies carried out by Baker *et al.* (2002, 2008), which investigated the role of cross-language similarity perception in L2 speech learning among Korean bilinguals in the U.S. The participants in these studies stayed in the L2-speaking country for one and nine years, and could be considered typical 'immigrant learners'. The present study asked similar questions to those posed by Baker *et al.*, but in a different context: that of European migration and a medium length of residence in the target language country. In addition, it employed a different methodological design, albeit comparable in theoretical justification. Also, this study supplemented the

quantitative analysis of the data by qualitative analyses to a greater extent than the Baker *et al.* (2002, 2008) studies. The present study thus offered important insights into child-adult differences in the acquisition of non-native sounds.

Finally, the present study sought to determine how Polish learners of English perceive and produce some specific (Irish) English vowels after about three years of residence in Dublin. No study to date has investigated the two languages in contact from a phonetic point of view. Such an examination carries both theoretical and practical importance. Theoretically, this study is important in the advancement of adequate L2 speech models of bilingual processing. In practical terms, such an understanding may help to determine what types of training and encouragement may be most effective for migrant L2 learners.

8. Major hypotheses of the present study

The major hypothesis of this study was that both age of L2 learning and L2 experience influence the ability to perceive discrepancies between L1 and L2 sounds. This ability, in turn, affects how accurately L2 sounds are perceived and produced. Specific hypotheses of the study are presented in greater detail below.

8.1. Cross-language phonetic similarity perception in L2 speech learning

The first hypothesis of this study is that *the ability to perceive differences between L1 and L2 sounds aids accurate perception and production of L2 sounds*. Relatively few studies to date have examined to what extent cross-language phonetic similarity perception aids L2 speech learning. In addition, it is currently unknown whether children perceive the similarity between L1 and L2 sounds differently from adults, and whether this ability explains the different outcomes in their L2 phonological acquisition. Baker *et al.* (2002, 2008) studies have indicated

that cross-language phonetic similarity perception may, at least partially, predict L2 speech learning.

8.2. Age effects in L2 speech learning

The second hypothesis for this thesis is that *children will be more accurate than adults in the perception and production of L2 vowel sounds.* This hypothesis is based on the recurrent findings of previous research, and mainly, on the tenet of the Speech Learning Model (Flege, 1995), which claims that child L2 learners are more likely to accurately distinguish between L1 and L2 sounds, since their developing L1 sound system does not act as a strong attractor of L2 sounds, and therefore, they form separate phonetic categories for L1 and L2 sounds. Consequently, their perception and production of L2 sounds is more accurate. On this view, children will acquire L2 vowel sounds closer to native-like levels than will adults.

8.3. Experience effects in L2 speech learning

The third hypothesis for this study is that *after three years of stay in the target language country, L2 migrant learners will perceive and produce L2 vowels more accurately than L2 learners without such experience (formal L2 learners).* Previous research has suggested that learners with substantial naturalistic experience in the L2 perceive and produce L2 sounds more accurately as they gain experience in the target language (Flege, Bohn and Jang, 1997; Flege and Liu, 2001; Levy and Strange, 2008). It is also hypothesized that child L2 learners will benefit from the naturalistic learning experience more, and therefore that their L2 performance will approximate that of age-matched native speakers more so than will the performance of adult L2 learners, as the former will be exposed to more intensive and richer L2 input (Jia and Aaronson, 2003; Tsukada *et al.,* 2005).

The next chapter introduces the participants of the present study, the stimulus material, and manner of data collection for the research project.

Chapter 3

Methodology

1. Introduction

In order to test the hypotheses presented in Chapter 2, the participants in this study performed cross-language assimilation, speech perception, and speech production tasks in their second language (English) after about three years of residence in an English-speaking country (Ireland). They also completed an extensive background questionnaire, which was designed to elicit information about their use of English, use of Polish, L2 motivation and attitudes towards learning languages. This chapter gives a detailed description of the nature of both the linguistic and non-linguistic data sought from the participants, and the manner of collection of such data.

2. Participants

A group of 40 native Polish (NPI) participants, who reported no learning disabilities and having normal hearing, was recruited from the Polish Diaspora Project[6] in Dublin, and divided into two equal subgroups according to each participant's age on arrival in Ireland: 20 children (between the ages of 8 and 12 years) and 20 adults (aged 21 years and older). These divisions roughly allow for some comparisons across the developmental stages discussed in the literature on L2 phonological acquisition. For example, Bond and Adamescu (1979) showed that young learners aged 4 and adolescents between the ages of 11 and 13 perceive

[6] "Second language acquisition and native language maintenance in the Polish diaspora in Ireland and France", a joint project between Trinity College Dublin and University College Dublin, was carried out under the auspices of the Irish Research Council for the Humanities and Social Sciences between 2007 and 2009. Recruitment of participants was carried out by the researcher in the summer of 2009, via advertisements in Polish newspapers, shops, on notice-boards related to the Polish church in Dublin, and via personal contacts. The Polish children were recruited in the Polish weekend school in Blackrock, Co. Dublin.

novel speech sounds differently than do adults over 25 years of age. Further, Scovel (1988) and Long (1990) suggested that 12 years of age is an important threshold for learning to speak an L2 authentically. In addition, applying these subgroup divisions based on age of L2 learning allows for comparisons across developmental stages found in L1 phonological acquisition (Hazan and Barrett, 2000; Johnson, 2000). This is important because of the theoretical motivation for this study, i.e. the prediction that the level of development of L1 sound system at the time of L2 learning may affect the way L2 sounds are perceived and produced.

The participants were further selected on the basis of their length of residence in Ireland. They were required to have arrived in the country in the immediate aftermath of Poland´s accession to the EU in 2004. This feature of the design of the study made it possible to gain insights into a particular stage of development of their L2 speech learning in a specific type of migrant environment.

The adult Polish participants in this study had mostly benefited from tertiary education and were experienced language learners in terms of their foreign language learning histories. For instance, they often reported having learnt Russian and/or German in the past. The Polish children recruited for the study could also be described as multilingual speakers. They were attending diverse primary and secondary schools in Dublin at the time of the study, and those younger than 11 years upon arrival in Ireland were also acquiring Irish at school (see Table 3.1. below for the participants' language learning backgrounds). Their parents had varied occupations in Ireland, ranging from construction workers, housewives, and shop assistants to teachers, artists, and doctors. In the majority of cases, the participants had received some formal instruction in the English language in Poland before coming to Ireland. In fact, only one NPI adult reported no previous experience with English upon arrival, whereas nine children had not learnt any English before they arrived in Ireland.

Additional languages (besides English)	**Groups**						
	NPI adult	***NPI child***	***NPP adult***	***NPP child***	***NS adult***	***NS child***	***Total***
Irish	0	3	0	0	4	6	13
German	5	2	1	1	0	0	9
French	1	5	1	1	0	0	8
Russian	3	0	3	1	0	0	7
Italian	1	0	0	0	0	0	1
2 additional languages	5	4	2	0	6	2	19
3 additional languages	5	4	1	0	0	2	12
No additional languages	0	2	1	7	0	0	10
Total	20	20	9	10	10	10	79

Table 3.1. Participants' language learning backgrounds

The control group of native Irish English-speaking participants (NS) comprised 10 children and 10 adults chosen on the basis of their place of birth (Dublin) and of not speaking or learning Polish as an additional language, even though they were multilingual speakers. Another control group of 19 native Polish (NPP) speakers (10 children and 9 adults) living in Poland and with no English immersion experience was also included in the project. The members of this group were mostly attending formal English language classes with non-native (Polish) teachers at the time of the study, and their proficiency in the language ranged from beginning to advanced levels. These participants were recruited to bear something of a linguistic resemblance to a group of Polish migrants as they might be on the first day of their arrival in the host country. An attempt was made to equalize the number of participants in each subgroup and to match the groups of children and adults as closely as possible in age, social background, and multilingual learning experience. The dimension the researcher was unable to control for in selecting participants for this study was the gender ratio in the group of Polish children and adults living in Ireland. Whereas more female adults volunteered to participate in the study, there were more Polish boys who took an interest in the research and were present at school at the time when the study was conducted. This was not deemed critical, however, as no gender differences have been reported for L2 speech perception and production tasks such as those used here. Concerning the differences inherent in the experiences of the participants who were attending

formal English classes in Poland and those who were living in Ireland, especially in terms of L2 input (Muñoz, 2008), these were not strictly controlled for either, since it was not the aim of the study to compare the effect of the types of learning contexts on L2 phonological acquisition. Rather, the reason for including age-matched Polish children and adults living in Poland in the project was that this cross-sectional perspective promised to offer some insight into how Polish speakers may have perceived and produced the tested L2 vowels at the beginning of their migrant experience in Ireland and how they coped with the sound system of the L2 after about three years of stay in the target language country.

All 40 NPI participants responded to a background questionnaire, which asked them, *inter alia*, to report their use of the English and Polish languages in their everyday life in Ireland, and their attitudes towards learning the target language. In addition, their English proficiency levels were formally examined through the administration of a standardized pen-and-paper placement test (*Anglia Examination Syndicate*, Chichester College, England)[7]. This placement test was chosen since it was validated for child L2 learners as young as five years, and mapped to the Common European Framework of Reference (CEFR; Council of Europe, 2001)[8]. The NPP participants were also asked to complete a brief background questionnaire, which elicited information about their English language learning histories; however, they were not required to sit for the English language placement test.

[7] See Appendix 1 for a copy of the Anglia Placement Test (Anglia Examination Syndicate, January 2009).

[8] It is to be noted that the Anglia Placement Test (2009) does not offer adapted CEFR descriptors for child L2 learners. The proficiency levels distinguished in the test were used mainly for comparative purposes. In addition, it was believed that an introduction to the system of the CEFR for languages might be useful for the NPI participants, who may utilize this information e.g. in job applications within the EU, and upon entrance to language courses at established language institutes in Europe.

Groups	AOA	Age	AOE	LOR	CEFR	L1 use	Number of participants (gender)	Tasks
Polish children in IRL (NPI)	7–12 (9.85)	12–15 (13.2)	6–12 (8.4)	1–5 (3.35)	1–5 (3.5)	2–4 (3.0)	20 (M=13, F=7)	1. English placement test 2. Cross-language perception 3. Categorical perception 4. Delayed-repetition 5. Questionnaire 6. Semi-structured interview
Polish adults in IRL (NPI)	21–49 (26.7)	24–53 (29.7)	5–29 (13.95)	1–5 (3.2)	1–6 (4.15)	1–5 (3.2)	20 (M=7, F=13)	1. English placement test 2. Cross-language perception 3. Categorical perception 4. Delayed-repetition 5. Questionnaire 6. Semi-structured interview
Polish children in PL (NPP)		10–12 (11.1)	4–10 (6.2)				10 (M=4, F=6)	1. Cross-language perception 2. Categorical perception 3. Delayed-repetition 4. Questionnaire 5. Semi-structured interview
Polish adults in PL (NPP)		27–48 (33.11)	9–26 (14.78)				9 (M=4, F=5)	1. Cross-language perception 2. Categorical perception 3. Delayed-repetition 4. Questionnaire 5. Semi-structured interview
Irish children (NS)		9–14 (11.4)					10 (M=5, F=5)	1. Categorical perception 2. Delayed-repetition 3. Semi-structured interview
Irish adults (NS)		25–42 (29.5)					10 (M=5, F=5)	1. Categorical perception 2. Delayed-repetition 3. Semi-structured interview

Table 3.2. Participants in the study

Means for the following participant characteristics are provided in the brackets:
age of arrival (AOA); age of testing (Age); age of first exposure to English (AOE);
length of residence in years (LOR); L2 proficiency (CEFR), where A1 = elementary level: 1,
A2 = beginner: 2, B1 = intermediate: 3, B2 = upper-intermediate: 4, C1 = advanced: 5, C2 = native-like: 6;
and L1 use: 1 = much more Polish, 3 = half and half, 5 = much more English.

As shown in Table 3.2. above, NPI participants differed in their age of arrival (AOA), age at the time of testing (Age), and age of first exposure to English (AOE). AOE was impossible to control for because of the recent changes in the language educational policies in Poland, which now encourage an introduction of foreign language classes at an increasingly early age. In addition, for some learners, AOE corresponded to their AOA. However, a one-way ANOVA test revealed no significant differences between the age-matched participant groups in terms of age at the time of testing ($p>.05$).

The dimensions on which the NPI participants were comparable included length of residence in Ireland (LOR), English language proficiency (CEFR), and the reported use of the native language in Ireland (L1 use). The adults' level of English language proficiency was slightly higher, but this was presumably due to the adults' greater familiarity with sitting for formal language tests rather than differences between actual language skills in the participant groups. The results of an independent samples *t*-test showed no statistically significant difference between the NPI participants' English proficiency levels [$t(38)=1.477$, $p=.148$].

The number of participants in each group and the tasks that they were required to complete are also presented in Table 3.2. As can be seen, data from only nine NPP adults were included in the study. This was because one male participant from Poland produced his speech with a cracking voice, to such an extent that his productions might have potentially suffered from bias in subsequent native speaker evaluation. Therefore, the data from this participant were not included in the final analysis.

The participants were not paid for their time; rather, they were personally motivated to participate. The NPI adult participants received a letter of confirmation concerning their participation in the study, including their CEFR score in the English language placement test. Their performance on the perception and production tasks was preliminarily analyzed by the author shortly after the session, and the results

were discussed with the participants in a feedback form via email. The data collection from the young Polish participants was realized under strict ethical guidelines in a school setting in both Ireland and Poland. After the researcher had received formal consent for their participation in the study from the school principals, class teachers, parents and the young participants themselves, the Polish children were consistently approached in a supportive manner, which emphasized the enjoyable aspect of taking part in the study. It took approximately one hour for the NPI participants to complete the set of tasks, while NPP participants—not required to sit for the English language placement test—needed about 40 minutes to complete the tasks. NS participants—not tested for cross-linguistic perception—spent approximately 20 minutes on the completion of the testing session. Information about their educational and language learning background was elicited in a brief semi-structured interview at the start of the session.

3. Stimuli

The stimulus corpus used in the present study was produced by three adult female speakers of Irish English (all long-term residents in Dublin, two in their early thirties and one in her early fifties), whose speech was recorded in a sound-proof booth in the Phonetics Laboratory at Trinity College Dublin. The use of three speakers, rather than one, was motivated by an interest in eliciting spectral and temporal differences in the acoustical signal that are assumed to be non-problematic for native speakers, but which may be challenging for non-native speakers (Strange, 2007). Vowel sounds were chosen for investigation in this study because they are more suitable for testing language-specific sound categorization than are consonants, given the fact that they are fewer in number and as such more variable among languages. The phonological structure of Polish vowels is

much simpler relative to English vowels, and thus a number of specific predictions about assimilation of L2 vowels into respective L1 sounds could be tested. Moreover, no study to date has examined native Polish speakers' perception of Irish English vowel sounds. Finally, previous research suggests that both perception and production of L2 vowel sounds can be especially challenging for L2 learners (Flege, 1988; Flege, MacKay and Meador, 1999; Flege, Yeni-Komshian and Liu, 1999).

The vowels chosen for analysis in the present study included: /i/, /ɪ/, /ɛ/, /æ/, /ɔ/, /əʊ/, /u/, and /ɜ/[9]. They were placed in a bVt word context, which is frequent and productive to a comparable extent in both Polish and English. Although perception of L2 vowels can be affected by the phonetic environment in which they occur (Trofimowich, Baker and Mack, 2001; Levy and Strange, 2008; Strange, 2007), this study did not aim to examine all possible contexts in relation to perception of the eight selected L2 vowels by the Polish learners of English. Instead, this study controlled for a specific CVC environment, which is present in both languages and which embeds real L1 and L2 words that differ minimally in the realization of the mid-vowel. Table 3.3. below presents the L2 stimuli used for the study:

/i/	**/ɪ/**	**/ɛ/**	**/æ/**	**/ɔ/**	**/əʊ/**	**/u/**	**/ɜ/**
beat	bit	bet	bat	bought	boat	boot	but

Table 3.3. L2 stimuli used for the three language tasks in this study

In total, each of the native Irish English speakers produced 24 monosyllabic words (8 tokens × 3 repetitions) in a carrier phrase "I say _____ for you". The L2 words were chosen in such a way that they represented a range of difficulties as predicted by the speech learning models discussed earlier (Best, 1995; Flege, 1995). The carrier phrase was supposed to allow for more natural

[9] For phonetic descriptions of Irish English vowel /ɜ/ see Section 3.1. below on Irish English vowel inventory.

tokens; in addition, the word *for* was selected to be used in the carrier phrase in order to reduce possible co-articulation effects.

The words were randomly presented on index cards, and the speakers were instructed to produce the sentences "as if they were speaking to a friend who is a native speaker". The recordings were then edited using the Praat software programme (Boersma and Weenink, 2009), for native speakers' identification and goodness judgement ratings. Another three native speakers of Irish English, all of whom were linguists from Trinity College Dublin, identified the bVt words and rated the goodness of the vowel production in the words on a 7-point Lickert scale (7=best). Overall identification was 81% across the words, and the goodness ratings ranged between 2 and 7 for the 8 tested vowels. Only those instances of Irish English vowel productions that were uniformly identified and judged to be very good exemplars of native vowel categories by speakers of the same variety of English—i.e. received a goodness rating 5 and above by all the raters—were selected and used in further perception and production tasks. During the validation phase, two of the stimulus words (*boat* and *bit*) were judged to be produced inconsistently by two of the female speakers. Therefore, as they did not reach the criterion of a maximum goodness rating, the *boat* and *bit* words were re-recorded using a fourth female Irish English speaker (from Dublin, aged in her thirties). The same recording conditions were strictly adhered to as in the original recording session. The fourth native speaker's production of the words concerned were judged as exemplary by the researcher, and were therefore incorporated into the stimulus material of the study.

3.1. Irish English vowel inventory

Standard descriptions of the Irish English vowel inventory (Wells, 1982; Hughes, Trudgill and Watt, 2005) distinguish twelve vowels and three diphthongs: two front tense vowels /i/, /e/, three front lax vowels /ɪ/, /ɛ/, /a/, one central vowel /ə/, three back lax vowels /ʊ/, /ʌ/, /ɑ/, and three back tense vowels, /u/, /o/, and

/ɔ/. The diphthongs are comprised of /aɪ/, /aʊ/, and /ɔɪ/ sound combinations. The most salient vowel sound of Irish English is that of /ʌ/, which is typically produced as a mid-centralized, back, somewhat rounded vowel, and as such more precisely transcribed as /ʊ̈/[10] (Kallen, 1994) or /ʌ̈/ (Hickey, 2008). In the variety of English spoken in Dublin, there occurs free variation between neutralization of the vowel (i.e. its realization as /ʊ/) and /ʌ/, depending on the socio-educational background of the speaker (Wells, 1982; Hughes, Trudgill and Watt, 2005; Hickey, 2008).

According to Hickey (2005, 2008), Dublin English has experienced a major sound change as a result of a changing socio-economic climate for the capital city during the past two decades. Distinguishing between popular (local) Dublin English, a fashionable (cosmopolitan) variety of English spoken in the capital, and a supra-regional Southern (neutral) variety of Irish English, Hickey (2008) provides the following overview of lexical set realizations, as relevant to this study:

Lexical set	Rural Northern[11]	Popular Dublin	Fashionable Dublin	Supraregional Southern
FLEECE (beat)	iː	iʲə	iː	iː
KIT (bit)	e	ɪ	ɪ	ɪ
DRESS (bet)	ɛ̨	ɛ	ɛ	ɛ
TRAP (bat)	a	æ	æ	æ
GOOSE (boot)	ʉ(ː)	uʲə	uː	uː
STRUT (but)	ʌ	ʊ	ʌ	ʊ̈
THOUGHT (bought)	ɔː	aː	ɔː, oː	ɒː
GOAT (boat)	ɔʊ, oː	ʌɔ	əʊ	əʊ, oʊ

Table 3.4. Lexical sets for Irish English vowels, as relevant to this study (adapted from Hickey, 2008)

[10] In order to avoid confusion, the symbol /ʊ̈/ has been adopted throughout this study to depict the specific realization of the Irish English vowel /ʌ/, unless the intention is to distinguish between /ʌ/, as known from mainstream English language varieties, and the /ʊ̈/ vowel sound of Irish English.

[11] The realizations of relevant northern Irish English vowels are included in the table since there is evidence suggesting that some phonological features of the northern variety, such as /u/-fronting, may extend far down the east coast of Ireland (*A Sound Atlas of Irish English,* 2005).

As shown in Table 3.4 above, the largest variations in the pronunciation of Irish English vowels to which English learners living in today's Dublin are likely to be exposed are the vowels occurring in the lexical sets of STRUT, THOUGHT and GOAT.[12] In contrast, the phonological input in terms of the FLEECE, KIT, DRESS, and TRAP lexical sets can be expected to be fairly uniform in this regard.

For a general reference, the Irish English vowel chart (Ní Chasaide, 2001) is presented below (Figure 3.1), together with information on the acoustic properties of the vowel stimuli used in the cross-language similarity task of this study.

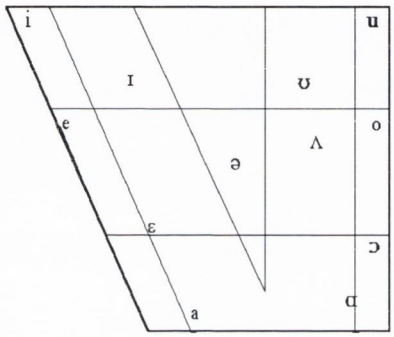

Figure 3.1. Vowel chart of Irish English (excluding diphthongs) (according to Ní Chasaide, 2001)

The F1 and F2 values presented here in Table 3.5. were obtained from the eight vowel tokens (in a bVt context) spoken by one of the young female Irish English speakers. The acoustic measurements were performed by using the Praat software programme (Boersma and Weenink, 2009).

Irish English vowel	F1	F2
/i/	255	2790
/ɪ/	426	2331
/æ/	820	1381
/ɛ/	648	1382
/u/	354	1788
/ʊ/	566	1150
/ɔ/	646	974
/əʊ/	538	1232

Table 3.5. F1 and F2 values of the vowel stimuli used in this study

[12] It is notable that the Irish English diphthong /əʊ/ can be realized as a monophthong or a narrow diphthong (Hughes, Trudgill and Watt, 2005).

3.2. Polish language vowel inventory

In comparison with Irish English, the Polish language vowel inventory is discernibly much smaller. Gussmann (2007) identifies six oral vowels and two nasal nuclei: four front vowels /i/, /ɨ/, /ɛ/, /a/, two back vowels /ɔ/, /u/, and two mid vowels /ɛ/, /ɔ/ which are followed by a nasalized labio-velar glide, in some cases a nasalized palatal glide. The orthographic nasal vowels <ę, ą> are thus sometimes regarded as diphthongs rather than as typical nasal vowels. The presented segments basically exhaust the scope of the Polish vowel system, since there are no oral diphthongs in the language, just as there is no quantity distinction. As for word stress, this typically falls on the penultimate vowel of Polish words, and unlike in English, unstressed vowels are never reduced. Finally, no regional variation has been reported in terms of vowel sounds realizations in the standard Polish language.

The Polish vowel chart, as provided in the *Journal of the International Phonetic Association* (2003) is reproduced in Figure 3.2.

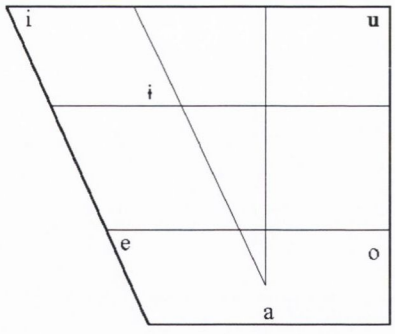

Figure 3.2. Vowel chart of Polish (excluding nasal vowels) (according to Jassem, 2001)

Formant frequency values for Polish vowels in the bVt context are not available and those for Polish vowels in contexts not identical to that of Irish English are not reported here since direct comparisons between vowels in different contexts have been shown to be inappropriate (e.g. Strange, 2007). Nevertheless, a general comparison of the relevant Polish and Irish English vowel sounds is offered in the

next section to indicate possible tendencies for Polish learners' perceptual mappings of the sounds.

3.3. Comparison between Polish and Irish English vowel sounds

As shown in sections 3.1. and 3.2., Polish and Irish English vowel inventories differ in a number of phonologically specifiable ways. While sounds such as /i/ and /ɛ/ occur in both languages, the vowel /ɵ̈/ is a specific sound of Irish English with realizations stretching between Polish /a/, /o/ and /u/. Polish vowel /i̇/ is close in articulatory vowel space to English /ɪ/, although previous research suggests that Polish speakers tend to produce the sound closer to English vowel /i/ (Szpyra-Kozłowska, 2010) and often discriminate the /i/-/ɪ/ contrast on the basis of duration differences between the English high front vowels (Bogacka, 2004). The English vowel /æ/ has been shown to be assimilated to the Polish vowels /a/ or /ɛ/ by Polish learners, and distinguished from English /ɛ/ on the basis of duration cues as well (Rojczyk, 2010). It is worth noting that the English vowel /u/, as presented in this study, shows high F2 values, which suggests that there is a tendency for speakers of Dublin English for its frontal realization (cf. Hickey, 2005); and as such it differs acoustically from Polish back vowel /u/. Finally, the English vowel /ɔ/ is similar, yet not identical, to Polish /o/, while the monophthongized /əʊ/ is quite different from the Polish /o/ in that it is pronounced higher and more frontally in the oral cavity.

Within the interpretation of Best's PAM (1995), the tested L2 contrasts in this study fall into the following assimilation patters: the /i/-/ɪ/ pair falls into the Single-Category pattern; the pairs /ɛ/-/æ/ and /ɪ/-/ɛ/ fall into the Two-Category assimilation pattern, the pair /ɔ/-/əʊ/ falls into the Category-Goodness assimilation pattern; and the last pair /u/-/ɵ̈/ falls into the Categorized-Uncategorized assimilation pattern. Consequently, PAM predicts the order of perceptual difficulty for these contrasts as (from least to most difficult): /ɪ/-/ɛ/, /ɛ/-/æ/, /u/-/ɵ̈/, /ɔ/-

/ʊ/, and /i/-/ɪ/. One notes that these predictions are made on the basis of expected perceived relationships between the Polish and Irish English vowels, rather than on the basis of measurements of the acoustic differences between the segments. This is important for testing the main hypothesis of this study, which proposes that *perceived* cross-language similarity between L1 and L2 sounds will affect perception and production of the L2 sounds. Also, it is to be recalled that PAM predicts the various assimilation patterns for perception of L2 sound contrasts in adult learners, and, in addition, in those who are either beginning L2 learners or lay listeners. One of the goals of this study is to examine whether the predictions of the PAM model are equally applicable to young L2 learners, and more generally, to migrant L2 learners who have been exposed to the target language for several years (cf. Guion *et al.*, 2000; Baker *et al.*, 2002, 2008).

4. Data collection

The phonological data from the adult participants in the study were collected in a quiet language laboratory room at the Centre for Language and Communication Studies at Trinity College Dublin, under the supervision of the researcher. Being fluent in Polish herself, and by interacting with the participants in both English and Polish, she attempted to ensure that during the first task performance—the cross-language identification task—a bilingual language mode was activated in the learners (Grosjean, 1997). Also, this research approach helped to create a fairly relaxed environment for both the adults and especially the children throughout the protocol. The remaining L2 perception and production tasks were introduced and conducted in English, unless misunderstanding occurred. The same procedure was applied with the child participants, with the exception of the location of the task administration. The young participants were visited in their school or home environment, where the tasks were administered in a quiet room. While the

adult participants were tested individually, the research was undertaken with the children in pairs or groups of three, in order to create a familiar, non-testing environment for them. The limitations of time in the school setting also dictated such an approach.

The stimuli were auditorily presented over headphones or loud speakers, with visual stimuli on a computer screen. Answer sheets were provided in a pen-and-paper format (see Appendix 2). All tasks were presented via a visually attractive PowerPoint Presentation, which was paced by the researcher. The participants' productions were recorded as digitized sound files (22.05 kHz, 16-bit resolution), using a professional digital recorder, ZOOM Handy Recorder H4.

4.1. Cross-language phonetic similarity task

As is the case for methods used in related studies (e.g. Baker *et al.,* 2008; Guion *et al.,* 2000; Strange, 2007), native Polish-speaking children and adults participating in the present study heard eight Irish English vowels /i/, /ɪ/, /ɛ/, /æ/, /ɔ/, /əʊ/, /u/ and /ʊ̈/ in a bVt format presented one at a time. The moment the Irish English stimulus was presented, six Polish keywords in their orthographic form were displayed on the screen. These represented the six vowels of the Polish sound system, and included: *bity*[13] ('beaten'), *byty* ('entities'), *buty* ('shoes'), *bety* ('bedding'), *baty* ('whips'), and *boty* ('high boots'). The fact that the Polish keywords consisted of two syllables, while the Irish English stimuli were monosyllabic, was not viewed as problematic, since, as discussed earlier, stress typically falls on the penultimate vowel of Polish words, and there is no phonetic distinction between stressed and unstressed vowels in the Polish language. Careful attention was paid to the selection of such words that were based on the same consonantal context in order to make the testing format comparable across the

[13] The phonetic transcription of the Polish key words is as follows: *bity* /biti/, *byty* /bɨti/, *buty* /buti/, *bety* /bɛti/, *baty* /bati/, and *boty* /bɔti/.

languages, and also, to ensure the use of only real words which were likely to elicit a natural speech processing/mapping condition.

The participants heard the eight target words (*beat, bit, bat, bet, boat, bought, boot* and *but*) in two repetitions. In each case, they first heard the word and matched the vowel in the stimuli to one of the six Polish keywords shown on the screen (or, in other words, to the Polish vowel sound) to which they believed it was most similar. For example, when they heard the word *beat*, the task was to decide which Polish sound was most similar to English /i/ in that word. Second, they made goodness-of-fit judgements regarding the similarity of the English vowel they had just heard and the Polish vowel they had chosen, using a 7-point Lickert scale, with a score of "1" indicating that the sounds were not at all alike and a score of "7" indicating that the sounds were a complete match. For example, it was predicted that the native Polish speakers would rate /i/ in *beat* as very similar to the Polish vowel /i/ in *bity*. Participants were encouraged to use the entire scale and to follow their first impression in completing the task. They could listen to the English words several times, if they desired, but they were not allowed to change their answers once they were given, in order to maintain the impressionistic element in the task (see Appendix 3 for the protocol related to this cross-language identification task).

To ensure that the participants understood the task, and to lend validity to the task, both Polish children and adults were asked to read aloud the list of Polish keywords from the screen and to concentrate on how 'the middle sound' of the word sounded to them. Then they underwent a brief practice session with two English stimuli from the real task. The participants were encouraged to discuss their first impressions about the stimuli with the researcher, and they were also given visual prompts on screen with possible answers. They were reminded that it was important to approach this task bearing in mind that there were no 'right' or 'wrong' answers, and, accordingly, it was suggested to them that basing their answers on spontaneous impression was undoubtedly the best strategy. Figure 3.3. below

depicts the screen that the participants could see during the practice session for the cross-language similarity task. During the testing session, the participants marked their responses in an answer sheet by circling their choices (Appendix 2).

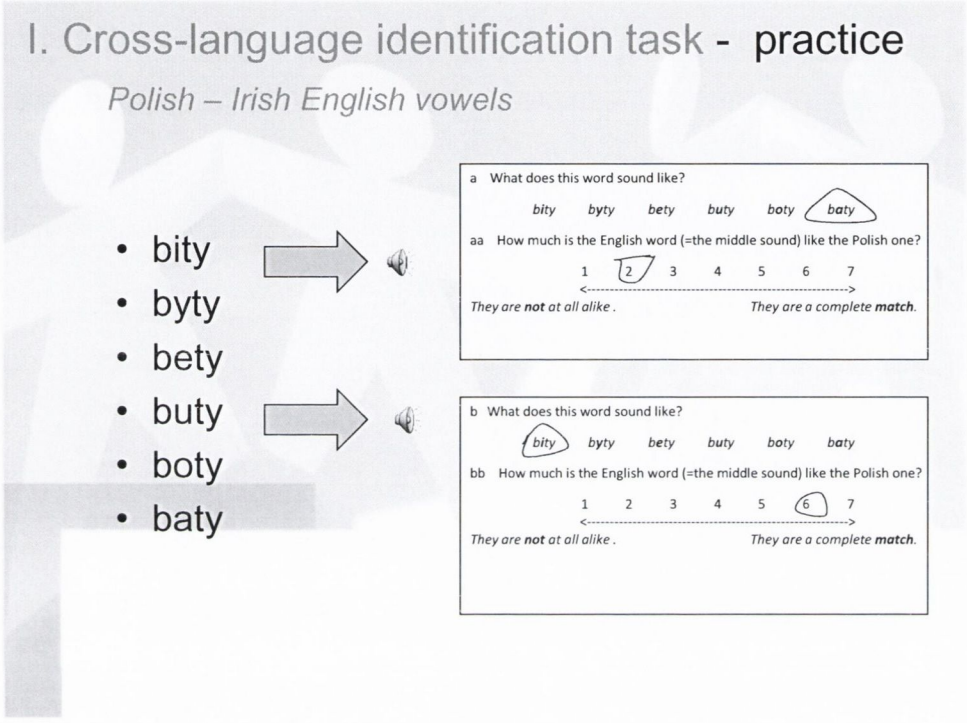

Figure 3.3. Practice session screen: cross-language similarity task

A series of *t*-tests for paired samples showed no significant difference between the means of goodness ratings in the two repetitions across participant groups [$t(58)=0.37$, $p=.971$] or within participant groups [NPI adults: $t(19)=1.022$, $p=.320$; NPI children: $t(19)=-1.226$, $p=.235$; NPP adults: $t(8)=1.474$, $p=.179$; NPP children: $t(9)=-1.253$, $p=.242$]. An informal analysis of the distribution of the assigned categories for each of the eight vowels, using a cross tabulation procedure, also revealed no significant differences between the first and second identifications within the groups. Therefore, only the first responses were used for further analyses, as these were understood to be those that were given under the first impression by the participants.

4.2. Categorical discrimination task

To test the Polish participants' perceptual abilities in terms of the chosen non-native sounds, a categorical discrimination task (see Appendix 4) was used. Specifically, a categorical discrimination task in an oddity format was chosen because of its advantages of being employable with both adults and children, of being reliable, and of being capable of testing long-term memory representations of L2 segments (Flege, 2003b).

In an oddity categorical discrimination task, the participants are asked to indicate which vowel in a triad of naturally produced stimuli is different from the other two by, for example, ticking one of the following labels: 1,2,3, and ☺. In other words, they are required to choose the odd item out from a given set of words. For example, if the first token in the triad is different from the other two (such as in *beat-bit-bit*), the correct answer is "one"; if the second is different (*beat-bit-beat*) the correct choice is "two"; and so on. In categorical discrimination tasks, also 'catch-tokens' are included, which represent a case where all three items are the same. The no-change sets are employed to test the participants' ability to ignore audible but phonetically irrelevant within-category variation. In the present study, the participants had an option to indicate such a case by circling a "smiley" face. As in the previous task, the participants were allowed to listen to the stimuli as many times as they desired.

The stimuli for the categorical discrimination task were the (Irish) English vowel contrasts /i/-/ɪ/, /ɛ/-/æ/, /ɪ/-/ɛ/, /ɔ̈/-/u/, and /ɔ/-/əʊ/. Each of the five vowel pairs was presented in combinations, such as *beat-beat-bit*, *bit-beat-bit*, *beat-bit-bit*, and *beat-beat-beat*, using all possible combinations. In total, 38 triad items (5 contrasts × 6 change combinations + 8 no-change tokens) were presented to the participants. The inter-stimulus interval between the members of each pair contrast was set for 1.5 seconds, in order to reduce the possibility that a correct response could be based on information in auditory short-term memory. Halfway through the

task, a short break was taken to allow the participants to rest from this relatively demanding, in terms of concentration, part of the testing session.

To ensure that the participants understood the task, two steps were taken. First, the researcher provided the participants with two examples deemed to be clearly illustrative. While pointing to her fingers, suggesting counting to three, she pronounced the words *fish-fish-apple,* eliciting the participant's indication that the "third" token was different in this triad. Another illustration, using an *apple-fish-apple* example followed. Second, a brief practice session was allowed, using five chosen word sets. The stimuli presented in the practice session differed from the actual task, however: only those vowels that were supposed to be easily distinguishable were used, such as *beat-beat-bought*, in order to ensure that the participants understood the task and felt encouraged to perform it; in addition, they were given feedback on their answers. This feedback was intended to motivate them to respond reliably in the actual task. Participants were not given feedback in the actual task. Figure 3.4. depicts the screen that the participants were shown during this practice session.

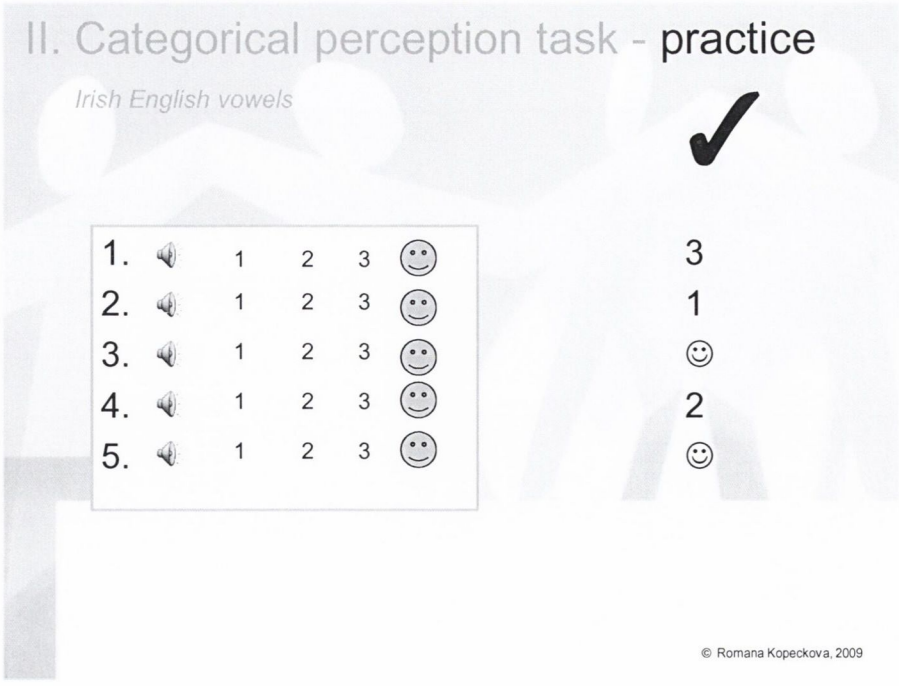

Figure 3.4. Practice session screen: categorical discrimination task

An A' (A prime) score[14] was calculated for each contrast to reduce the possible effect of response bias. The A' scores are based on the proportion of 'hits' and 'false alarms'[15]. Hits are defined as the correct selection of the odd item out in change trials. False alarms are defined as the incorrect selection of an odd item out in no-change trials. An A' score of 1.000 indicates a perfect sensitivity to a vowel contrast, whereas an A' score of .500 represents a theoretically defined chance level of response, i.e. a lack of sensitivity. This type of analysis of L2 categorical perception is commonly employed in the current research in the area.

4.3. Delayed-repetition task

Production abilities in the Polish learners' L2 were tested in a delayed repetition task (see Appendix 4), which elicited the same vowels that were used in the previous two tasks: /i/, /ɪ/, /ɛ/, /æ/, /ɔ/, /əʊ/, /u/ and /ʊ̈/. This type of task was preferred to an immediate repetition task to avoid the possibility of the direct imitating of the stimulus production. Children in particular are known to exploit this ability very effectively. Furthermore, a picture-naming task was not chosen for this study, because it was not possible to depict some of the target words in a picture format. In this production task, therefore, the participants were asked to listen to a stimulus sentence "I say_____ for you" in English, and then to repeat the sentence as if in a reaction form: "And now I say_____ for you". The sentences were elicited twice from all participants, in order to ensure that productions with errors caused by the testing situation could be taken out of the analysis. If no such removal of erroneous productions was needed, the second

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[14] An A' score represents a non-parametric index for sensitivity and bias (Snodgrass *et al.*, 1985):

$$A' = 0.5 + \frac{(HIT-FA)\cdot(1+HIT-FA)}{(4\cdot HIT)\cdot(1-FA)} \quad \text{if } H > FA; \qquad A' = 0.5 - \frac{(FA-H)\cdot(1+FA-H)}{(4\cdot HIT)\cdot(1-H)} \quad \text{if } FA > H;$$

[15] Since it was not permissible (due to factors of time and possible fatigue) to include an equal number of 'hits' and 'false alarms' for each contrast in this study, the weight of 'false alarms' was calculated in relation to the weight of 'hits', and used in further calculations of the A' scores. Specifically, out of 38 triads, 8 were non-change triads and as such open to 'false alarms', as opposed to 30 change-triads. Each participant's score for false alarms was thus proportionally adjusted by a ratio of 3.75 (=30/8). See Appendix 5 for the distribution of correct responses.

production—assumed to be the more naturally and comfortably produced by the participants—was chosen for a subsequent intelligibility task.

The intelligibility task involved 7 NS listeners evaluating each participant's production of the target vowels (79 participants × 8 productions = 632 items). The listeners comprised both those who had some background in linguistic research and those of a non-linguistic background, so that a representative sample of raters was included in the study. The raters were 4 men and 3 women from Dublin, aged between 23 and 66 years (mean=36.29). None of them had ever learnt Polish as an additional language.

In a self-paced online presentation,[16] the raters were asked to listen to a single word (which was previously edited from the participants' productions of the carrier sentences) and to identify which vowel sound they had just heard by selecting one of the eight tested vowels from a drop-down menu. The vowels were presented in the IPA format, followed by a lexical example to assist those participants who might not have been familiar with phonetic transcriptions of words. The listeners could also select the response 'other' for tokens that could not be placed in any of the target English vowel categories. If uncertain, the listeners were encouraged to make their best guess. Choosing the correct response determined whether the L2 learner was able to produce the sound accurately enough for a native speaker to identify it. The results of the intelligibility task were calculated in terms of the correct target identifications by the seven listeners.

[16] For presentation of the intelligibility task, *QuestionPro Survey Software (Corporate Licence)* was used. This online presentation software supports audio presentations in an mp3 format and a wide variety of design tools. In this study, the listeners could save their responses at any time they desired and continue later. On average, it took them 80 minutes to complete the whole task. Two blocks of presentations were designed, which were integrated into two separate surveys/links; however, these were chained and thus it was possible for the listeners to continue in one go if they so wished. However, the participants were encouraged, also through the design of the task, to take breaks during the task. The division of the task into two parts (comprising separate children's and adults' audio files) was also motivated by the requirement to administer the task in two different orders.

4.4. Background questionnaire and semi-structured interview

On the basis of related studies (Jia and Aaronson, 2003) and recent research into motivation in L2 learning (Dörnyei and Ushioda, 2009; Norton, 2000), as well as of insights gained after conducting pilot interviews with the Polish Diaspora Project participants, a background questionnaire was developed (Appendix 6) for use in the present study. It was administered in a pen-and-paper format. Two comparable versions of the same questionnaire were developed, in order to reflect the language style of children and adults, as well as the realities of their respective learning environments. Both versions were piloted on a large sample of Polish people living in Dublin. Respondents could choose whether to fill in a Polish- or an English-language version of this questionnaire, and they could also write their answers to open-ended questions in Polish in the English version, if they so wished.

The questionnaire was designed to elicit general biographical, socio-psychological and language-educational data from the participants. Specifically, the participants were asked to report on their learning experience with English, i.e. the age and context in which they first learnt English, how positive this learning experience was, whether they were taking any extra lessons in English at the time of testing, in which contexts and how frequently they were using English, as well as who the English speakers they were communicating with in English in their everyday life in Ireland were. Similarly, they reported on use of their native language, in terms of frequency and kind of contact with Polish speakers. In addition, they were asked about the balance of their English and Polish use in their day-to-day life in Ireland. The third section of the questionnaire explored the respondents' motivation for and attitudes towards acquiring English as an L2. For example, they were asked about their perceptions of how difficult it was for them to understand Irish English, or how important they found it to sound native-like in English. Their attitudes towards learning the sound system of English was specifically probed in questions about systematic feedback on their English

pronunciation, whether they were satisfied with their English pronunciation, and whether they tried to imitate the (Irish) English accent. Last but not least, respondents were asked questions about their identification with the Irish people and levels of happiness of living in Ireland. Three open-ended questions tapping into their ideal and ought-to L2 selves (Dörnyei, 2005) were also included. The final section of the questionnaire elicited general biographical information, such as age at the time of testing, length of residence in Ireland, socio-educational background of the adults, professions of the children's parents, and other foreign language learning experience.

In order to validate and to gain greater insights into the aforementioned issues, a follow-up semi-structured interview was conducted with each individual participant at the end of the contact session, in which he/she was asked to elaborate on some of the questionnaire items, such as reminiscences of successful L2 communication or moments of uneasiness in speaking English. Space was also provided for personal comments on the experience of the testing session. Notes were taken immediately afterwards by the researcher and used in further analysis to support a qualitative dimension of the collected data (see Appendix 3 for details).

The next chapter presents the results of the perception and production tasks used in this study, as well as some of the questionnaire data. After specific predictions related to the participants' performance in their L2 are reviewed, corresponding data analyses and summaries are provided.

Chapter 4

Results

1. Introduction

The main hypothesis of this study is motivated by the SLM (Flege, 1995) prediction that child L2 learners are less likely than adults to assimilate L2 sounds into L1 sound categories, because their L1 sound system is still developing and consequently exerts low assimilative power. On this basis, it is predicted that child L2 learners will perceive and produce L2 sounds more accurately than will adult L2 learners. To test these hypotheses, as described in Chapter 2, a cross-language identification and similarity rating task was first undertaken. In this task, the Polish participants matched eight Irish English vowel sounds with the Polish vowels they believed these were most similar to, and rated their degree of similarity on a scale ranging from 1 (meaning "the sounds were not at all alike") to 7 (meaning "the sounds were a complete match").

Second, a categorical discrimination task was performed by the participants, to determine their perception of eight (Irish) English vowel sounds, and to ascertain whether judgements of cross-language similarity do indeed explain and predict L2 perceptual abilities. In this task, the Polish and Irish participants were asked to choose an "odd item out" from triads of five vowel contrasts.

Third, a delayed-repetition task determined the Polish participants' accuracy in the production of the tested vowels. Their efforts in this regard were evaluated by seven native speakers of Irish English in an intelligibility task, and were also related to the judgements of cross-language similarity.

Finally, the results of the perception and production tasks were related to the data collected from the Polish participants via a detailed background questionnaire.

2. Cross-language phonetic similarity perception

As discussed in Chapter 2, different measures of cross-linguistic similarity have been used in L2 speech studies to date. The most advocated at present is the use of perceptual identification tasks in combination with goodness-of-fit ratings. In this study, an assimilation task employing a 'fit index' metric was used (Guion *et al.*, 2000; Cebrian, 2006), since it allowed the combination of data on L2 vowel identification and goodness-of-fit ratings into a single value, and it also facilitated relating this value to data on L2 discrimination and L2 production. In addition, weighting the identification scores by the goodness-of-fit ratings helped to raise the scores of those identifications that were indeed considered good exemplars of the native category and, in turn, to lower the scores of those identifications that were selected because they had no good competitors.

2.1. Predictions

Analyses of the results from the perceptual assimilation task in this study centre on two independent variables: age of L2 learning and L2 experience. Thus, the major predictions of this task were: 1) that L2 child learners would be less likely than L2 adult learners to perceptually assimilate the tested Irish English and Polish vowel sounds, and 2) that learners with L2 migration experience would be more accurate in perceiving similarities and differences between Irish English and Polish vowels than would learners without such experience (i.e. formal L2 learners). In addition, specific predictions about the relationships between (Irish) English and Polish vowel sounds were made. These are presented in Table 4.1., and explained below. All the predictions were formulated in line with the SLM (1995) and PAM (1995, 2007) hypotheses introduced in Chapter 2, and with the phonetic similarity comparisons of the Irish English and Polish vowel sounds made in Chapter 3.

Irish English vowel	Predicted primary response	Predicted relationship pattern	Young age effect	Migration experience effect
/i/	/i/	Two-to-one	Less equation	More equation
/I/	/i/	Two-to-one	Less equation	Less equation
/æ/	/a/	One-to-one/	Less equation	Less equation
	/ɛ/	Two-to-one	Less equation	Less equation
/ɛ/	/ɛ/	One-to-one/	Less equation	More equation
		Two-to-one	Less equation	More equation
/u/	/u/	Two-to-one	Less equation	More equation
/ɔ̈/	/u/	Two-to-one	Less equation	Less equation
/ɔ/	/o/	Two-to-one	Less equation	Less equation
/əʊ/	/o/	Two-to-one	Less equation	Less equation

Table 4.1. Predictions for the cross-language similarity task

First, it was predicted that English vowel contrast /æ/ and /ɛ/ would be perceived either on a one-to-one basis with Polish /a/ and /ɛ/, respectively, or on a two-to-one basis with Polish /ɛ/. With growing L2 experience in a naturalistic environment, Polish learners were, however, expected to perceive that the English vowel /æ/ might not be the best exemplar of Polish /a/ or /ɛ/ and to equate the two sounds less. Second, it was predicted that the other tested vowel contrasts might be more confusing for Polish learners of English because they were likely to be perceived on a two-to-one basis, i.e. each member of the L2 pair was likely to be mapped on to one L1 sound. However, for participants with migrant L2 learning experience, it was expected that one of the members of the pair would be perceived as a better perceptual fit than the other member. In particular, English /i/ was predicted to be perceived as more similar to Polish /i/ than English /I/ would be to the same Polish sound. Similarly, it was predicted that English /u/ should be perceived as a better perceptual fit to Polish /u/ than Irish English /ɔ̈/. Finally, it was predicted that the English vowel /ɔ/ would be given a higher, albeit low, similarity rating to the Polish vowel /o/ than would the Irish English narrow diphthong /əʊ/.

To summarize, it was predicted that NPI learners with migrant L2 experience would map L1 and L2 vowels more accurately than would NPP learners with formal L2 experience; would come to perceive highly similar native and non-native sounds as representatives of a single 'merged' phonetic category; and would assign divergent fit ratings to sounds that are less similar in acoustic terms. These patterns of perceived relationship between the (Irish) English and Polish vowels were predicted to be more prominent in children, on the assumption that children are better able than adults to distinguish between L1 and L2 sounds (Flege, 1995).

2.2. Data analysis

Analyses of the cross-language identification judgements revealed that both children and adults selected the same Polish vowel as the primary (most frequent) response alternative[17] in their classification of the tested sounds, with the exception of the case of the Irish English vowel /ɔ̈/. Whereas the majority of NPI adults perceived this sound to be similar to the Polish vowel /o/, NPI children classified it mostly as Polish /u/. A reverse pattern was found for NPP adults and NPP children. The classifications of all the (Irish) English vowels tested in this study are listed in Table 4.2. below, which shows the frequency of classifying an L2 vowel as corresponding to an L1 counterpart; the 1.00 value indicates that all participants chose the same response for the L2 sound concerned. The majority of the Polish participants heard English /i/ as Polish /i/, English /æ/ as Polish /a/, English /u/ as Polish /u/, English /ɔ/ as Polish /o/, English /ɛ/ as Polish /ɛ/, English /əʊ/ as Polish /o/, and English /ɪ/ as Polish /i/. It is noteworthy that the English vowel /ɪ/ was also perceived as very similar to Polish /ɨ/ by a third of the NPI children.

[17] Analyses presented in this chapter are based on the primary response alternative data, as relevant for individual groups (see Table 4.2.).

Irish English vowel	Most common identification (Polish vowel)	Proportion of identifications	Mean goodness ratings	Fit index
/i/	NPI adult /i/	0.90	5.11	4.59
	NPI child /i/	0.95	4.42	4.19
	NPP adult /i/	0.89	4.00	3.56
	NPP child /i/	1.00	5.10	5.10
/I/	NPI adult /i/	0.95	4.68	4.45
	NPI child /i/	0.70	4.57	3.20
	NPP child /i/	0.89	2.88	2.56
	NPP adult /i/	1.00	4.30	4.30
	NPI child /i̇/	0.30	5.50	1.65
/æ/	NPI adult /a/	1.00	4.75	4.75
	NPI child /a/	0.95	4.37	4.15
	NPP adult /a/	0.89	3.75	3.34
	NPP child /a/	0.90	3.56	3.20
/ɛ/	NPI adult /ɛ/	1.00	5.30	5.30
	NPI child /ɛ/	0.95	4.89	4.65
	NPP adult /ɛ/	0.78	4.14	3.22
	NPP child /ɛ/	1.00	4.40	4.40
/u/	NPI adult /u/	0.90	4.06	3.65
	NPI child /u/	0.95	4.11	3.90
	NPP adult /u/	1.00	3.11	3.11
	NPP child /u/	1.00	4.20	4.20
/ɔ̈/	NPI adult /u/	0.35	3.14	1.09
	NPI child /u/	0.60	4.25	2.55
	NPP adult /u/	0.67	3.33	2.23
	NPP child /u/	0.40	3.00	1.20
	NPI adult /o/	0.55	3.36	1.85
	NPP adult /o/	0.33	3.67	1.21
	NPP child /o/	0.60	3.83	2.30
/ɔ/	NPI adult /o/	1.00	4.90	4.90
	NPI child /o/	0.95	4.79	4.55
	NPP adult /o/	1.00	3.22	3.22
	NPP child /o/	1.00	4.80	4.80
/əʊ/	NPI adult /o/	0.95	3.53	3.35
	NPI child /o/	0.85	3.35	2.85
	NPP adult /o/	0.67	2.50	1.68
	NPP child /o/	0.70	3.57	2.50
	NPP adult /u/	0.33	2.00	0.66
	NPP child /u/	0.30	3.67	1.10

Table 4.2. Cross-language identification and similarity matrix

Despite the similarities in overall patterns of cross-language identification between the Polish children and adults, important differences were noted in terms of the participants' judgements of phonetic similarity. The similarity ratings (fit indices), also shown in Table 4.2., were calculated by multiplying the proportion of responses receiving the modal identification by the mean goodness rating for that identification, the assumption being that the higher the fit index for an L2 sound, the higher the perceived similarity between an L2 sound and a corresponding L1 category. Only identifications that made up more than 30% of all responses are

included in Table 4.2. Where relevant, the primary response alternative is highlighted.

Overall, the non-native vowels /i/, /ɛ/, /æ/ and /ɔ/ were considered to be good perceptual fits with the native Polish counterparts, while the vowels /ɔ̈/ and /əʊ/ were identified as poorly related to any Polish vowel category by all the participants. The fit indices ranged from a low value of 1.68 (the fit of English /əʊ/ with Polish /u/), as rated by most NPP adults, to a high value of 5.30 (the fit of English /ɛ/ with Polish /ɛ/), as rated by most NPI adults. NPI children rated the English vowels /i/, /ɪ/, /æ/, /ɛ/, /ɔ/ and /əʊ/ as being *less similar* to the modal Polish response alternatives than NPI adults did. In contrast, NPP children rated all the tested vowels except /æ/ as being more similar to the Polish counterparts than NPP adults did.

A one-way ANOVA test yielded a significant group effect for the overall fit index scores [$F(3,55)=2.831$, $p=.047$]. When Tukey's post-hoc test was applied, it was found that it was NPI and NPP adults who significantly differed in their overall fit index scores ($p=.030$). NPI children did not significantly differ from NPI adults in their judgements of similarity of the tested vowel sounds ($p>.10$). Nor did NPP children significantly differ from NPP adults in their evaluations of the match between the English and Polish vowels ($p>.10$). Thus, in contrast with what was hypothesized, the children's and adults' ratings of similarity between L1 and L2 vowels in this study did not significantly differ, although there was a trend for NPI children to be less likely than NPI adults to perceive the tested L2 sounds as good instances of L1 categories (cf. Bond and Adamescu, 1979; Baker *et al.*, 2002, 2008). Interestingly, the trend was reversed for the NPP children and the NPP adults (Figure 4.1.).

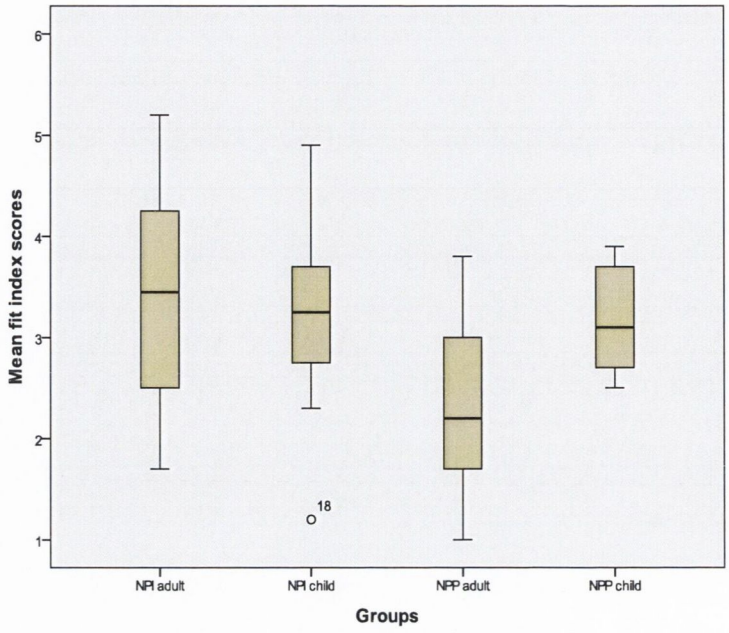

Figure 4.1. Box plots for mean overall fit index scores

Regarding the effect of L2 experience on the ratings of perceptual similarity between the tested vowel sounds, the Tukey's post-hoc test revealed that NPI adults significantly differed from NPP adults in their evaluation of the English vowels /ɛ/ and /ɔ/ as being more similar to Polish /ɛ/ and /o/ (p=.029 and p=.030, respectively). However, the differences between NPI children's and NPP children's ratings of the similarity of each of the tested vowels did not reach significance (p>.40).

These results suggest, on the one hand, that NPI adults did benefit from their L2 immersion experience, in that they were more accurate in their perception of similarities between those L2 vowels that are good perceptual fits to L1 vowels. For their part, NPP adults tended to separate all the English vowels from L1 vowels, regardless of their acoustic relationship, thus keeping the sound systems of the two languages apart. On the other hand, NPI children and NPP children performed comparably, distinguishing between those L2 and L1 sounds that are distant across the two languages, while coming to perceive similar L2 and L1 vowels as representatives of a single phonetic category. The prediction relating to the effect of L2 migration experience on the NPI children's accuracy of cross-language

perception was thus not supported. Table 4.3. below summarizes the results, showing which predictions for each of the English vowels found support in the current study. The "√" mark indicates a confirmatory trend for the predictions, and * that this trend is significant at the .05 level (see Appendix 8 for detailed group statistics).

L2-L1 vowel relationship	Mean fit index scores	Young age effect	Migration experience effect
/i/ - /i/	NPI adult: 4.59		√
	NPI child: 4.19	√	X
	NPP adult: 3.56		
	NPP child: 5.10	X	
/ɪ/ - /i/	NPI adult: 4.45		X
	NPI child: 3.20	√	√
	NPP adult: 2.56		
	NPP child: 4.30	X	
/æ/-/a/	NPI adult: 4.75		X
	NPI child: 4.15	√	X
	NPP adult: 3.34		
	NPP child: 3.20	√	
/ɛ/-/ɛ/	NPI adult: 5.30		√*
	NPI child: 4.65	√	√
	NPP adult: 3.22		
	NPP child: 4.40	X	
/u/-/u/	NPI adult: 3.65		√
	NPI child: 3.90	X	X
	NPP adult: 3.11		
	NPP child: 4.20	X	
/ʊ/-/u/, /o/	NPI adult - /o/: 1.85		√
	NPI child - /u/: 2.55	X	X
	NPP adult - /u/: 3.23		
	NPP child - /o/: 2.30	√	
/ɔ/-/o/	NPI adult: 4.90		√*
	NPI child: 4.55	√	√
	NPP adult: 3.22		
	NPP child: 4.80	X	
/əʊ/-/o/	NPI adult: 3.35		X
	NPI child: 2.85	√	X
	NPP adult: 1.68		
	NPP child: 2.50	X	

Table 4.3. Results for the cross-language similarity task

Before further analyses were conducted on the data of this study, two post-hoc analyses were run to rule out the possibility that these results may have been influenced by the children's inability to perform the perceptual assimilation task as intended. First, the response alternatives provided by the Polish children and adults in response to each English vowel were examined. If the children had been guessing during the task, they could have, at least to a certain extent, provided implausible or inconsistent answers. The analysis, however, revealed that both the

children and the adults offered acoustically viable answers. For example, in response to English /ɪ/, the participants chose the same two response alternatives, Polish /i/ (high, unrounded, front vowel) and Polish /ɨ/ (high, unrounded, central vowel). Because these two vowels are located in the same region of the vowel space as English /i/, they were considered viable response alternatives. Second, the consistency of the participants' answers was determined by running a one-way ANOVA on the number of response alternatives given by the children and the adults for each of the tested vowels. This analysis was motivated by the idea that if the children had experienced difficulty in performing the task, they would have chosen numerically more response alternatives than the adults in the task. This analysis yielded no significant difference between the children's and the adults' overall number of response alternatives [$F(55,3)=1.297$, $p=.285$], suggesting that both the children and the adults responded to the task with the same level of consistency.

2.3. Summary

As the NPI children were not more likely than the NPI adults to choose inexplicable or inconsistent answers, the findings reported earlier can be taken as evidence for the SLM hypothesis that children are less likely than adults to assimilate L2 sounds and L1 categories, at least as far as the English vowels in a bVt context tested here among Polish learners are concerned. There was a numerical trend for the NPI children to assimilate six of the eight L2 vowels with the corresponding native vowels to a lesser extent than the NPI adults, although this trend did not reach statistical significance.

In terms of the NPP children's and NPP adults' performances on the tasks examined, the differences did not reach statistical significance either, although the findings on perceptual similarity for the NPP participants displayed a converse pattern to that found for NPI children and NPI adults. The NPP children perceived the tested L2 vowels as more similar to the chosen L1 vowels than the NPP adults

did. In addition, the NPP children tended to perform in this task comparably to the NPI children. The NPP adults, in turn, differed significantly from the NPI adults in giving lower similarity ratings to the tested vowels.

Finally, the three-year-long migration experience effect on the predicted accuracy of perceptual similarity between L2 and L1 sounds was found only in the performance of the NPI adults, who distinguished between the tested English and Polish vowels more accurately than the NPP adults did, especially as far as L2 vowels that are acoustically close to L1 vowels were concerned. NPI children did not significantly differ from NPP children in their perceptual assimilation of the L2 and L1 vowels, suggesting that L2 children's perception of cross-linguistic phonetic similarity might show good accuracy levels from the start of L2 learning.

The results of the next two tasks indicate whether the differences in cross-language perception of Polish child and adult L2 learners are also to be noted in their discrimination and production of the (Irish) English vowels.

3. Categorical discrimination

The principal hypothesis of this study in relation to L2 perception is that the ability to perceive differences between L1 and L2 sounds, as measured by a cross-language perceptual task, predicts L2 perception abilities of learners with varying age of L2 learning and L2 experience. To determine the perception abilities in English of the Polish children and adults who participated in this study, a categorical discrimination task was designed in which the participants were asked to select an anomalous item out of triads of English minimal pair words.

As explained in the methodology chapter, unbiased non-parametric measures of response sensitivity—A prime (*A'*) scores—were calculated for the purpose of analysing the categorical discrimination task (Snodgrass *et al.,* 1985). An *A'* score of 1.000 represented perfect discrimination of a contrast, while an *A'* score of 0.500 and lower suggested performance at a chance level. The *A'* scores

were calculated for each of the five L2 vowel contrasts (/i/-/ɪ/, /æ/-/ɛ/, /i/-/ɛ/, /u/-/ɔ̈/, and /ɔ/-/əʊ/) and six groups of participants (NPI adults, NPI children, NPP adults, NPP children, NS adults and NS children). Comparisons to age-matched English native speakers were included to ensure that the perceptual abilities of the L2 child and adult learners could be taken as a reflection of their L2 learning abilities, rather than being due to developmental differences.

It should be noted that any findings of age effects in this task should not be construed as deriving from the child participants' possible inability to perform at the task as intended. All participants were required to pass a pre-test on similar stimuli to determine that they in fact understood the task (see Chapter 3 for details).

3.1. Predictions

Analyses of the results of the categorical discrimination task used the same variables as the cross-language similarity task, i.e. age of L2 learning and L2 migration experience versus formal L2 learning experience. The main predictions with respect to this task were: 1) that child L2 learners would be better able than adult L2 learners to discriminate between tested L2 contrasts, and 2) that with migration experience this ability would be more accurate in both children and adults.

On the basis of the results of previous research (Best, 1995; Flege, 1995; Baker *et al.,* 2002, 2008), as well as of the results on the cross-language phonetic similarity task in the present study, the following predictions for each of the five tested English vowel contrasts were made. First, the L2 contrasts /ɪ/-/ɛ/ and /æ/-/ɛ/ were predicted to be easily discriminated by all Polish speakers, since they represent a vowel contrast that is based on a one-to-one relationship with the native vowel contrasts, /i/-/ɛ/ and /a/-/ɛ/, respectively, which should pose no discrimination difficulties for the Polish children and adults. Second, the (Irish) English vowel contrasts /i/-/I/, /u/-/ɔ̈/ and /ɔ/-/əʊ/, which were perceived on a

two-to-one basis with the Polish vowels /i/, /u/, and /o/, were expected to be difficult to discriminate, since they are confusable with a single native vowel sound. However, it was expected that the L2 contrast /u/-/ɔ̈/ would be discriminated fairly well, since one member of the pair—the distinct Irish English vowel /ɔ̈/—is presumably a 'new' sound to Polish speakers, and as such would be perceived as a poor fit to any L1 category.

As was shown in the results of the cross-language similarity task, most of the two-to-one L2 vowels were perceived on what PAM describes as a Category-Goodness Assimilation pattern; i.e. one of the members of the L2 contrast was perceived as a better perceptual fit to the corresponding L1 sound than the other member. This trend was found in both NPI children and NPI adults, with a non-significant tendency for NPI children to be more accurate in the distinction of the vowels included in the /i/-/ɪ/ and /ɔ/-/əʊ/ vowel contrasts. Hence, the NPI children were predicted to discriminate these sounds more accurately than NPI adults.

Significant experience effects were noted for adult NPI learners and their perception of cross-linguistic similarity of English vowels /ɛ/ and /ɔ/ with Polish /ɛ/ and /o/. Accordingly, it was predicted that NPI adults would discriminate the vowel pairs /æ/-/ɛ/ and /ɔ/-/əʊ/ more accurately than would NPP adults, although both groups were expected to perform relatively accurately, given the categorization patterns of the vowels with corresponding L1 categories. Further, the discrimination of the English vowel contrast /i/-/ɪ/ was predicted to show the least experience effect in all Polish learners, given the findings from the cross-language phonetic similarity task. Both English sounds were perceived as comparably similar to Polish /i/, although some NPI children perceived English /ɪ/ as being close to yet another L1 vowel, Polish /i/, and overall rated the vowel as less similar to Polish /i/ than NPI adults did. Finally, it was predicted that, with migration experience, it should be

easier for Polish speakers to discriminate the non-native vowel contrast /u/-/ɔ̈/, since they were likely to have formed a separate L2 vowel category for /ɔ̈/, eventually presumably perceiving the vowel contrast on a Two-Category basis (in PAM's terms). Table 4.4. provides a summary of these predictions.

L2 contrast	Categorization in PAM	L1 relationship	Initial discrimination	Young age effect	Migration experience effect
/i/-/ɪ/	Single-Category	Two-to-one	Hard	Easier	No difference
/æ/-/ɛ/	Two-Category	One-to-one	Easy	No difference	No difference
/ ɪ/-/ɛ/	Two-Category	One-to-one	Easy	No difference	No difference
/u/-/ɔ̈/	Categorized-Uncategorized	Two-to-one	Moderately hard	Easier	Easier
/ɔ/-/əʊ/	Category-Goodness	Two-to-one	Moderately hard	Easier	Easier

Table 4.4. Predictions for the categorical discrimination task

3.2. Data analysis

The first question that the categorical discrimination task sought to answer was whether child L2 learners discriminated L2 sounds more accurately than did adult L2 learners—i.e. whether the NPI children might be comparable in their performance to an age-matched group of native English-speaking children—and also whether the NPI children were better L2 perceivers than the NPP children.

To determine the L2 perceptual abilities of the six participant groups across the five L2 vowel contrasts, the Kruskal-Wallis test was applied. This non-parametric test was used in place of one-way ANOVA tests, since the assumption of normality for the distribution of *A'* scores for the participant groups in this study was not fulfilled (see Appendix 9). A significant group main effect was found for four of the five L2 vowel contrasts: /i/-/ɪ/ (χ_2 = 31.29, df = 5, p=.000), /ɪ/-/ɛ/ (χ_2 = 15.62, df = 5, p=.008), /u/-/ɔ̈/ (χ_2 = 18.37, df = 5, p=.003) , and /ɔ/-/əʊ/ (χ_2 = 31.57, df = 5, p=.000). Selected pair-wise comparisons on these vowel contrasts

were then made between the groups of participants, using a series of Mann-Whitney *U*-tests. The vowel pair /æ/-/ɛ/ was not discriminated significantly differently by any of the L2 learners in comparison to native speakers of English (p=.716), suggesting that this L2 vowel contrast is not perceptually difficult for Polish speakers.

As shown in Table 4.5. below, the NPI children did not significantly differ from the NPI adults in the discrimination of any of the tested vowel pairs. In the case of the vowel pairs /ɪ/-/ɛ/ and /æ/-/ɛ/, this result may have been caused by ceiling effects, as *A'* scores were high for both groups. The prediction about NPI children performing more accurately in the discrimination of the /i/-/ɪ/ and /ɔ/-/əʊ/ vowel contrasts because of their more accurate cross-linguistic perception of the vowels was thus not supported. In contrast, the prediction that NPI children's discrimination abilities would be comparable to those of age-matched native speakers was corroborated for four of the five tested L2 pairs, with the exception of the /i/-/ɪ/ contrast, suggesting that overall, NPI children discriminated between the tested L2 contrasts more accurately than NPI adults. In fact, NPI adults differed from their native English-speaking counterparts in the discrimination of two of the five tested L2 pairs, /i/-/ɪ/ and /ɔ/-/əʊ/.

Groups	L2 contrast	*U*-test	*p* level	Comparisons
NPI child-NPI adult	all		n.s.	
NPP child-NPP adult	all		n.s.	
NPI child-NS child	/i/-/I/	36.500	.004	NPI child < NS child
NPI child-NPP child	/i/-/I/	35.500	.003	NPI child > NPP child
	/ɔ/-/əʊ/	27.000	.001	NPI child > NPP child
NPI adult-NS adult	/i/-/I/	40.000	.007	NPI adult < NS adult
	/ɔ/-/əʊ/	52.500	.035	NPI adult < NS adult
NPI adult-NPP adult	/I/-/ɛ/	13.500	.000	NPI adult > NPP adult
	/u/-/ɔ̈/	24.500	.001	NPI adult > NPP adult
	/ɔ/-/əʊ/	24.500	.001	NPI adult > NPP adult

Table 4.5. Mann-Whitney U-tests for selected L2 perception comparisons

Similarly, no significant differences were found between the NPP children and the NPP adults in terms of their discrimination of all the tested vowel pairs. Once again, NPP children's discrimination of the vowel pairs /ɪ/-/ɛ/ and /u/-/ɔ̈/ was comparable to that of native speaking children in terms of accuracy, while NPP adults differed significantly from NS adults in discriminating all the tested vowel pairs.

The other question to answer in this task was that relating to an effect of migration experience on L2 perception. It was predicted, on the basis of the results of the cross-language task, that the NPI adults in particular would show greater accuracy levels in L2 perception of all the tested vowel pairs than would the NPP adults. This prediction was indeed supported for four of the five L2 contrasts, with the exception of the /i/-/ɪ/ pair. This vowel contrast showed low discrimination scores overall. As predicted, the contrast posed difficulty for all Polish learners, who performed at around a chance level in discriminating it (see Figure 4.2. below). It is notable, however, that the NPI children tended to perform better than any of the other Polish groups of learners in the discrimination of this difficult L2 pair, suggesting that at least some of these children may have been guided in performing at the discrimination task by their more accurate perceptual mapping of English /ɪ/ on to Polish /i/. Finally, NPI adults were successful in learning to discriminate the vowels pairs /ɪ/-/ɛ/ and /u/-/ɔ̈/ to native-like levels.

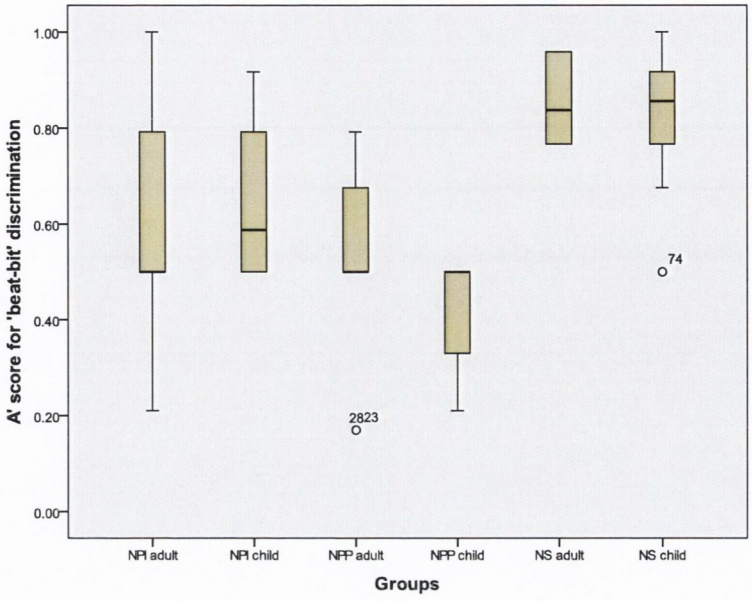

Figure 4.2. Box plots for the discrimination of the /i/-/ɪ/ vowel contrast

3.3. PAM: comparisons of perceptual difficulty for specific L2 contrasts

The predictions regarding the categorical discrimination task in this study were largely based on the tenets of the Perceptual Assimilation Model (Best, 1995). As discussed in Chapter 2, PAM claims that L2 learners' discrimination abilities are guided by their ability to perceive degrees of similarity between L1 and L2 sounds. On this basis, some assimilation patterns may lead to accurate L2 discrimination even by beginning L2 learners. Applied to this study, PAM predicts the order of perceptual difficulty for the five tested contrasts (from least to most difficult) as: /ɪ/-/ɛ/, /ɛ/-/æ/, /u/-/ɔ̈/, /ɔ/-/əʊ/, and /i/-/ɪ/, based on specific L2–L1 relationships (see Chapter 2, section 2.2. for explanation). In order to determine whether differences, in terms of perceptual difficulty, exist across the five vowel contrasts examined in this study, the results of the Kruskal-Wallis test reported above were further analysed, comparing each Polish participant group's *A'* scores for each of the five vowel contrasts (e.g. the NPI adults' mean ranks for discriminating /i/-/ɪ/, /æ/-/ɛ/, /ɪ/-/ɛ/, /u/-/ɔ̈/, and /ɔ/-/əʊ/ were compared). The findings of this analysis mostly support the tenets of PAM, although, contrary to the predictions, the

discrimination of the /u/-/ɔ̈/ contrast seems to have been more difficult for the Polish migrant learners than the discrimination of the /ɔ/-/əʊ/ contrast. Also, NPP adults' mean ranks were relatively erratic, while NPP children's mean ranks followed the predictions of the model fairly well (Table 4.6.).

PAM's order of perceptual difficulty	NPI adult (Kruskal-Wallis mean rank)	NPI child	NPP adult	NPP child
/i/-/ɛ/ (least difficult)	51.58	42.20	17.67	36.00
/ɛ/-/æ/	44.08	40.32	29.33	39.05
/u/-/ɔ̈/	43.50	39.70	15.94	30.65
/ɔ/-/əʊ/	44.38	43.12	16.00	16.70
/i/-/ɪ/ (most difficult)	37.12	38.25	27.72	17.75

Table 4.6. The order of perceptual difficulty for five L2 contrasts for Polish L2 learners

3.4. Summary

The main hypothesis of this task, that is that the ability to perceive differences between L1 and L2 sounds predicts L2 perception abilities, was partially corroborated in the study. Indeed, NPP adults, whose accuracy on the cross-linguistic task was the lowest, performed significantly less accurately in the discrimination of most of the tested L2 vowel contrasts, while NPI children, whose perception of similarities between the tested L1 and L2 vowels was most accurate, discriminated such L2 contrasts comparably to age-matched NS children.

No statistically significant differences were found between the perceptual abilities of NPI children and NPI adults, or between NPP children and NPP adults. In contrast, migration experience benefited both adult and child L2 learners, although the extent of the benefit that accrued differed depending on the L2 contrast. Adult L2 learners with migration experience tended to perform more accurately in the discrimination of those vowel contrasts that were not considered the most difficult in the light of native language phonology, while child L2 learners showed benefits of such experience across all L2 vowels. These findings are summarized in Table 4.7.

Comparison of groups	
	Age effects
NPI children and adults	none
NPP children and adults	none
NPI children and NS children	/i/-/ɪ/
NPI adults and NS adults	/i/-/ɪ/, /ɔ/-/əʊ/
	Experience effects
NPI children and NPP children	/i/-/ɪ/and /ɔ/-/əʊ/
NPI adults and NPP adults	/ɪ/-/ɛ/, /u/-/ɔ̈/, and /ɔ/-/əʊ/

Table 4.7. Results for the categorical discrimination task

4. Production

Another goal of this study was to determine whether cross-linguistic similarity perception explains and predicts the production abilities of L2 child and adult learners of different L2 experience. To determine the production abilities of the Polish learners of English who participated in this study, a delayed repetition task was designed, in which the same eight vowels were tested as in the previous tasks. The participants' productions of these vowels were evaluated in an intelligibility task by seven listeners, all of whom were native speakers of Irish English. The listener's responses were scored as either correct or incorrect. When the vowel intended by the participant and the vowel chosen by the listener matched, the response was scored as correct. For each participant, the percentage correctness score for a vowel was the proportion of correct responses out of seven (seven listener evaluations). The total percentage correctness for all eight vowels was the average of the percentage correctness scores for the eight vowels.

The listeners showed very good agreement rates in the identification of the vowels. Of the 632 vowel tokens (79 participants × 8 vowels), all seven listeners agreed on 228 (36%) of the tokens. Another 151 tokens (24%) were uniformly identified by six listeners. The agreement rate varied across vowels and speakers, ranging from 100% for /e/ produced by NS adults, to 5% for /ɔ̈/ spoken by NPI adults, as rated by at least six listeners. This suggests that disagreement among

the listeners was caused by ambiguity in the productions, rather than being due to listener factors.

4.1. Predictions

The main predictions for the delayed repetition task were similar to those for the cross-language perception and the categorical discrimination tasks. More specifically, it was predicted: 1) that child L2 learners would be more accurate than adult L2 learners in their production of the tested L2 vowels, and 2) that L2 migrant learners would produce the vowels more accurately than would formal L2 learners. On the basis of the results of previous studies (e.g. Tsukada *et al.,* 2005; Baker *et al.,* 2008) and the results of the cross-language perception task in the present study, the following predictions were made for the production abilities of Polish L2 learners for each of the eight English vowels in the task (Table 4.8.).

Irish English vowel	SLM categorization	L1 relationship pattern	Initial production	Young age effect	Migration experience effect
/i/	Similar	Two-to-one	Fair	No difference	Better accuracy
/I/	Similar	Two-to-one	Poor	Better accuracy	Better accuracy
/æ/	Somewhat similar	One-to-one	Fair	Better accuracy	Better accuracy
/ɛ/	Very similar	One-to-one	Good	No difference	No difference
/u/	Similar	Two-to-one	Fair	No difference	Better accuracy
/ɔ̈/	Distant	Two-to-one	Poor	Better accuracy	Better accuracy
/ɔ/	Similar	Two-to-one	Fair	No difference	Better accuracy
/əʊ/	Somewhat distant	Two-to-one	Poor	Better accuracy	Better accuracy

Table 4.8. Predictions for the delayed-repetition task

First, it was predicted that all Polish speakers would most accurately produce the English vowel /ɛ/, since it represents a good perceptual fit to a single Polish vowel category, as shown in the cross-language identification task. Similarly, the vowel /æ/, perceived on a one-to-one basis across the two languages, was predicted to be produced well by the Polish learners of English, albeit less

accurately than /ɛ/, since /æ/ was found to be judged as a worse perceptual fit to a single native vowel category. In contrast, although the vowel /i/ was also perceived as a good instance of a single vowel category, this sound was perceived on a two-to-one basis in relation to Polish /i/. That is, both members of the English vowel contrast /i/-/ɪ/ were perceived as good members of the same Polish vowel category. Given that it caused more perceptual errors, this perceptual assimilation pattern might also make production of the two vowels more difficult than the production of vowels perceived on a one-to-one basis. Thus, although it was predicted that English /i/ would be produced more accurately than English /ɪ/, it was also predicted that both of these vowels would not be produced more accurately than English /ɛ/ and /æ/. Similarly, English vowels /u/ and /ɔ/ were perceived on a two-to-one basis and rated as relatively similar to a single L1 category, hence their productions were expected to be less accurate, but still more intelligible, than productions of those L2 sounds that were perceived as 'new', or rather distant from any L1 category, i.e. the Irish English /ɔ̈/ and /əʊ/. These two vowel sounds were predicted to be produced poorly, especially by formal L2 learners.

Finally, it was predicted that child L2 learners might be more accurate in their production of the tested vowels, since they were less likely than were adult L2 learners to identify the tested vowels with similar L1 categories. In addition, adult L2 learners with migration experience were predicted to produce the L2 vowels better than adult L2 learners without such experience. This prediction was based on the finding in which cross-language similarity judgements of the English vowels differed according to L2 experience in the group of L2 adults in this study. Finally, previous research suggests that young learners commonly benefit from L2 experience to a greater extent than do adults in the development of L2 production skills (e.g. Tsukada *et al.,* 2005; Baker *et al.,* 2008). Thus, child L2 learners with

migration experience were expected to show accurate L2 production of most of the tested vowel sounds.

4.2. Data analysis

As explained previously, the results of the delayed repetition task were determined by calculating the percentage of correct productions in terms of intelligibility of each participant's production of the eight L2 vowels, as judged by seven native speakers of English. Since initial tests of homogeneity of variances on the individual vowel productions revealed that similar variances could be assumed only for /u/, /ɔ/ and /ɪ/ vowels, non-parametric tests of analysis were applied in this task, where individual vowel productions were evaluated. Overall L2 production accuracy scores, however, did satisfy the assumption of equal variances (p=.085), and therefore were analysed using parametric ANOVA tests (see Appendix 10). The participant groups comprised NPI adults, NPI children, NPP adults, NPP children, NS adults and NS children. Again, native speaker comparisons were included in order to capture the learners' production abilities in the L2 rather than developmental differences.

To compare overall L2 production accuracy scores between the participant groups, a one-way ANOVA was performed on the data, yielding a significant effect of group [F(5,73)= 14.526, p=.000]. A post-hoc Bonferroni test revealed that NPI adults differed significantly from NS adults (p=.000), but not from NPP adults (p=.475) in their L2 vowel production. For their part, NPI children did not differ from age-matched NS children (p=.297), but produced the tested L2 vowels significantly more accurately than did NPP children (p=.035). Overall, the production abilities of the NPI children and NPI adults did not differ significantly (p=1.000). As expected, NS children and adults did not significantly differ in their performance in this task either (p=1.000), although NS children scored somewhat lower in their production of the tested vowels (Figure 4.3.).

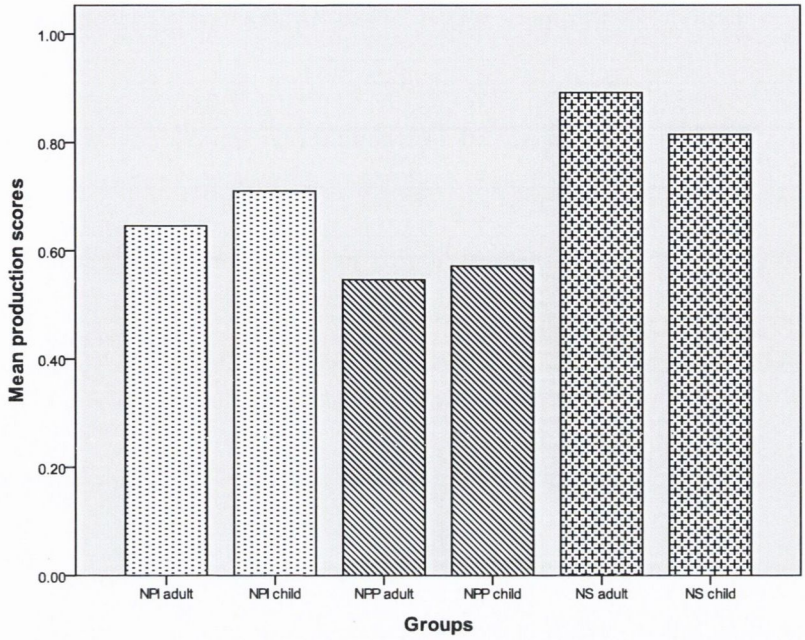

Figure 4.3. Bar chart for overall mean production scores

To determine on what vowel productions the groups of children and adults differed, a series of Mann-Whitney *U*-tests were performed. The results are summarized in Table 4.9., indicating selected significant results for comparisons of groups. The data show that although NPI children and NPI adults did not differ in their production accuracy of the tested segments overall, they did significantly differ in their ability to produce two of the L2 vowels, English /ɪ/ and Irish English /ɔ̈/. It is notable that the English vowel /ɪ/ was the perceptually challenging L2 sound that NPI children managed to perceive and discriminate more accurately than any of the other Polish participants, and eventually produced it as intelligibly as age-matched native speakers. Similarly, the specific Irish English vowel /ɔ̈/ was produced by NPI children to native-like levels, while NPI adults failed to produce this sound intelligibly enough for the native speakers to identify it. NPI adults, in fact, managed to perform accurately only in the production of those vowels that were acoustically close to L1 sounds and that they also perceived as particularly good instances of native language categories, i.e. English /i/, /ɛ/ and /ɔ/. In terms

of differences between NPP children and NPP adults in their L2 production, these did not reach significance in any of the tested vowels (p>.05).

Groups	L2 vowel	*U*-test	*p* level	Comparisons
NPI child–NPI adult	/ɪ/	97.000	.005	NPI child>NPI adult
	/ɔ̈/	105.000	.009	NPI child>NPI adult
NPI child–NS child	/i/	54.500	.032	NPI child<NS child
	/ə/	55.500	.046	NPI child<NS child
NPI child–NPP child	/ɪ/	33.000	.003	NPI child>NPP child
	/ɔ̈/	36.500	.005	NPI child>NPP child
	/əʊ/	32.000	.002	NPI child>NPP child
NPI adult-NS adult	/ɪ/	46.500	.017	NPI adult<NS adult
	/æ/	51.000	.021	NPI adult<NS adult
	/u/	29.000	.001	NPI adult<NS adult
	/ɔ̈/	6.000	.000	NPI adult<NS adult
	/əʊ/	37.500	.003	NPI adult<NS adult
NPI adult–NPP adult	/ɪ/	45.000	.032	NPI adult>NPP adult
	/ə/	40.000	.016	NPI adult>NPP adult

Table 4.9. Results for production of the tested Irish English vowels by selected participant groups

To further explore error pattern on the two L2 vowels that NPI children and NPI adults produced significantly differently, confusion matrices were created (Table 4.10.). Analyses of these matrices indicate that NPI adults' productions of /ɔ̈/ were misheard in approximately equal proportions with English /u/, /ɔ/ and /əʊ/. NPI children's productions did show similar confusion patterns—however, to a much lesser extent, and with the majority of them in fact producing this sound as intended.

Stimulus vowel (vowel elicited)	**Response vowels (vowel heard)**								
	/i/	/ɪ/	/ɛ/	/æ/	/u/	/ɔ̈/	/ɔ/	/əʊ/	other
/ɔ̈/					22	**33**	21	20	4
					16	**57**	5	16	6
/ɪ/	41	**53**	6						
	9	**80**	4		7				

Table 4.10. Confusion matrix for the productions of /ɔ̈/ and /I/ vowels by NPI adults (the first row) and NPI children (the second row)

The vowel /ɪ/ showed a concentrated confusion pattern in NPI adults, being most often heard as /i/, unless produced as intended. This finding points to the influence of the NPI adults' perception of high similarity between the two vowels. In contrast, this vowel /ɪ/ showed a slightly more diffuse confusion pattern in NPI children, being heard as /i/, /ɛ/, and /u/, but only in a very low number of cases, thereby indicating individual case confusion, rather than a systematic pattern. Thus, NPI children were shown to be more accurate in the production of these two challenging L2 vowels.

Regarding the predictions on the effect of L2 experience, NPI children performed significantly more accurately than did NPP children overall, and in the production of the vowels /ɪ/, /ɔ̈/ and /əʊ/, suggesting that the former had indeed benefited from L2 experience, regardless of the predicted difficulty of acquisition of specific L2 sounds. In fact, L2 children in this study with three-year-long migration experience did not differ significantly from native speaking children in their production of the tested L2 vowels. NPI adults, for their part, had apparently improved only those productions that were not related to 'distant' L2 sounds, i.e. English /ɪ/ and /ɔ/. While the former L2 vowel /ɪ/ was produced at levels about halfway between the accuracy of the L2 learner without naturalistic L2 experience and that of a native speaker, the vowel /ɔ/ was produced in a native-like manner by the NPI adults.

Given the foregoing findings on the effect of L2 experience in the vowel production of the NPI children and adults, further analysis was undertaken, in which relationships between the various dimensions of the learners' L2 experience and L2 production were explored.

4.3. Vowel production and L2 experience: some correlations

As discussed in the methodology chapter, L2 experience data were also collected from NPI children and NPI adults through a detailed background

questionnaire, supported by a follow-up semi-structured interview. The data obtained included information, *inter alia*, on the participants' contact with their L1 and L2 in diverse contexts, on their attitudes towards learning the sound system of English and, generally, their feelings about their migration situation. These data were explored in relation to the results of the production data reported in section 4.2. (for a detailed summary of the questionnaire data elicited from the NPI participants, see Appendix 7).

Based on the findings of previous research into the effect of L2 experience on L2 speech learning of children and adults in naturalistic settings (e.g. Jia and Aaronson, 2003; Jia *et al.,* 2006, Aoyama *et al.,* 2008), several potential predictors of performance were identified and subjected to a series of correlation analyses. The variables included: 1) age of first exposure to English, 2) the use of English with native speakers, 3) the use of English with non-native speakers, 4) the use of English with friends, 5) the use of English at work or at school, 6) total L1 use (a sum of reported frequency of use of the native language with family, friends, at school or at work, in leisure time, and in passive activities in everyday life in Ireland), 7) the importance of sounding native-like, 8) attempts at imitating an (Irish) English accent, 9) happiness levels in Ireland, and 10) length of residence in Ireland.

Bivariate correlations between total production accuracy and all of the predictive variables were first obtained for each group. For NPI adults, one significant correlation emerged: those who started their English instruction earlier tended to perform better on the L2 production task (r=.-578, p<.001). In the case of NPI children, better performance on the task was associated with a longer stay in Ireland (r=.515, p<.05). When separate analyses for the production of each of the tested vowels were conducted, some further trends for NPI children emerged. Those who produced the vowel /ɔ̈/ more accurately tended to be younger upon arrival in Ireland (r=-477, p<.05) and reported speaking Polish less in their

everyday life in Ireland (r=-473, p<.05). Correlations related to the NPI children's production of the vowel /ɪ/ (and other L2 vowels of this study) were found to be non-significant.

This relative lack of significant differences between NPI children and NPI adults in terms of their L2 learning experience (as correlated to their L2 vowel production) might not be surprising, for at least two reasons. First, the requirement in recruiting participants for this study was to match the NPI participant groups in their L2 learning experience as much as possible. Second, as discussed in Chapter 2, L2 experience effects in L2 acquisition are notoriously difficult to determine, given the changeable nature of L2 learning experience and challenges related to its measurement.

Nevertheless, it might be considered noteworthy that, overall, NPI children reported significantly more use of English with friends than NPI adults did (t=2.24, df=38, p=.031), and that frequent use of English with friends was associated in the sample (N=40) with greater use of English with native speakers (r=745, p<.01) and non-native speakers (r=335, p<.05), with more use of English at work or at school (r=460, p<.001), and with less use of Polish (r=-345, p<.05). In other words, the child L2 learners of this study seemed to enjoy a much more intensive contact with their L2 than their adult counterparts, mainly thanks to their friendships with both native and non-native speakers of English.

4.4. Summary

Age of L2 learning seemed to play a more prominent role in the production task than was found to be the case for both the cross-language perception task and the categorical discrimination task described earlier. This might be related to the fact that the production task, more than the other two, is more similar to actual language use and L2 learning experience. In particular, child L2 migrant learners produced the tested vowels in a way that was comparable to the production of NS children, including vowels that are perceptually different from any L1 vowel

category. Further correlation analysis suggested that their experience with learning the L2 differed from those of migrant adults, as the child L2 migrants frequently used the language with their L2-speaking friends. Adult L2 migrant learners, for their part, however, did not produce the tested vowels significantly differently from adult L2 learners without naturalistic experience, especially in the cases of 'new' L2 sounds.

Finally, the predictions based on the results of the cross-language task were upheld to some extent by the results of the production task. First of all, NPI children did not differ significantly from NPI adults in their overall perception of differences between L1 and L2 sounds, and neither did they differ in their overall L2 production. However, NPI children rated similarity between the tested L2 and L1 vowels lower than NPI adults did, and were found to perform in a native-like way in their L2 production. In contrast, NPI adults produced the L2 vowels significantly less accurately than NS adults. The results are summarized in Table 4.11. below.

Comparison of groups	
	Age effects
NPI children and adults	/I/ and /ɔ̈/
NPP children and adults	none
	Experience effects
NPI children and NPP children	/I/, /ɔ̈/, and /əʊ/
NPI adults and NPP adults	/I/ and /ɔ/

Table 4.11. Results for the delayed-repetition task

5. Relationships explored

The findings from the cross-language phonetic similarity task, categorical discrimination task, and delayed repetition task indicated that age of L2 learning, L2 experience and native language phonology all affect how L2 sounds are perceived and produced. First, it was found that age of L2 learning can affect how relationships between L1 and L2 sounds are perceived, and mainly, how accurately L2 sounds are produced. Second, migration L2 experience of about three years

seems to influence the L2 vowel perception and production of both child and adult L2 learners, with children's performance more like that of native speakers in both domains, but mainly in L2 production. In terms of cross-language phonetic similarity perception, L2 experience effects seem to be particularly notable in adult L2 learners.

To more fully explore the relationship between perception of cross-language phonetic similarity and L2 perception and production, between-tasks comparisons and an examination of *individual differences* are presented in the next section.

5.1. Perception of cross-language phonetic similarity and L2 speech learning

Although age of L2 learning and L2 experience were found to influence cross-language phonetic similarity judgements, as well as L2 perception and production abilities, such effects were not found across the same vowels in each task. Table 4.12. summarizes the results and shows on which vowels the age and L2 experience effects were found in each of the three tasks performed in this study.

Groups	Cross-language perception	Categorical discrimination	Production
NPI child vs. NPI adult (age effects)	/I/ and /ɔ̈/	none	/I/ and /ɔ̈/
NPP child vs. NPP adult (age effects)	none	none	none
NPI child vs. NPP child (experience effects)	/ɔ̈/	/i/-/I/ and /ɔ/-/əʊ/	/I/, /ɔ̈/, and /əʊ/
NPI adult vs. NPP adult (experience effects)	/ɛ/ and /ɔ/	/I/-/ɛ/, /u/-/ɔ̈/, and /ɔ/-/əʊ/	/I/ and /ɔ/

Table 4.12. Age and experience effects for the three tasks of the study

The summary of the results shows that the effects of cross-language similarity perception among the participants in this study were most notable in the production of the specific Irish English vowel sound /ɔ̈/ by the migrant learners. NPI children managed to acquire the sound to native-like levels in both their perception and production, while NPI adults were presumably still in the stage of forming or

'readjusting' an L2 category for the sound, and of finding ways of producing it. NPI children were also more accurate in their production of the vowel /ɪ/, presumably thanks to their perceptual assimilation of the sound not only to the Polish /i/, but also to an acoustically close Polish vowel /ɨ/. For NPI adults, the experience effects were most notable in perception as well as production of the vowel /ɔ/. Cross-language perception patterns, however, did not seem to be systematically related to L2 categorical discrimination and production by the L2 learners in this study, at least as far as their overall performance was concerned.

In order to explore whether qualitative analysis could shed more light on the role of cross-language phonetic similarity perception in L2 speech learning, an analysis based on individual differences between the groups and across the tasks was also undertaken. The outcome of this analysis is presented in the following section.

5.2. Individual differences in L2 speech learning

A further analysis of the data on the L2 discrimination and L2 production abilities of the participants in this study identified three different groups of learners, across age groups and experience levels: 1) a group consisting of L2 learners performing at *good accuracy* levels, as manifested by a performance falling within one standard deviation of age-matched native speakers' performance; 2) a group of L2 learners who scored within two standard deviations of the performance of age-matched native speakers, i.e. at a *fair accuracy* level; and 3) a group of L2 learners with *low accuracy* levels, performing below two levels of a standard deviation of the performance noted for native speaking children or adults. These groups, in addition, could combine low perceptual and productive abilities, low perceptual but high productive abilities, a reverse order of abilities, or high abilities in both L2 perception and production. Table 4.13. below lists the combinations and numbers of participants in each of the groups.

L2 ability	NPI adult (N=20)	NPI child (N=20)	NPP adult (N=9)	NPP child (N=10)	NS adult (N=10)	NS child (N=10)
Perception						
good	7	16	0	4	7	8
fair	3	2	0	0	0	0
poor	10	2	9	6	3	2
Production						
good	1	9	0	0	7	9
fair	3	5	0	3	2	1
poor	16	6	9	7	1	0
Good perception and production	1	6	0	0	5	8
Poor perception and production	9	1	9	3	1	0

Table 4.13. Individual differences in L2 vowel perception and production

The distribution of participants across ability groups reported in Table 4.13. indicates that child L2 learners were more likely than were adult L2 learners to discriminate L2 sounds accurately, since they dominated the 'good' group in L2 perception; although some adults also performed comparably accurately in the task. This result might be surprising, considering the fact that no significant differences were found between NPI children and NPI adults in the category discrimination task when evaluated at a group level. A similar trend was found for the production accuracy of the L2 learners, where a much higher proportion of NPI children than NPI adults fell within the group of 'good producers'.

In addition, the results suggest that there is a relationship between the two abilities of L2 learners. Indeed, a correlation analysis revealed a significant positive relationship between the learners' overall L2 perception and L2 production abilities (r=.346, df=59, p<.01). As shown in Table 4.13., there were 6 out of the 20 children and 1 out of the 20 adults who performed equally well in both perceiving and producing the English vowels, compared to age-matched native speakers. To illuminate the individual learning paths of these 'high achievers', a more detailed picture of the learner group is presented below, followed by an illustration of a group of child and adult learners who performed poorly in both L2 domains.

5.2.1. Child and adult L2 learners: individual learning paths

The group of successful L2 learners who participated in this study, in terms of their overall accuracy in L2 perception and L2 production, was a highly proficient group of English learners (CEFR: between B2 and C2) whose first English language learning experience went back to their pre-teenage years (for most of them to around seven years of age). These L2 children and adults gravitated towards English-speaking situations in their everyday life in Ireland, although frequent contact was also maintained with their native language. The NPI children reported a predominant use of English at school and with their English-speaking friends, who were more numerous than their Polish friends. Similarly, the one NPI adult who performed in a native-like manner in both L2 perception and production reported everyday use of English with native speakers at work and with friends in her leisure time. It is noteworthy that she held a degree in English, and before coming to Ireland at the age of 28 she had been taking intensive private lessons in English since the age of 10. At the time of the study, she had lived in Ireland for just one year.

In contrast, those NPI child and adult learners who showed low levels of L2 perception and production abilities also tended to have lower English proficiency levels (CEFR: A1 to B2) and had mostly started to learn English in adulthood. They often reported difficulties with understanding Irish English and perceived learning English as a challenging task. It might be interesting to note, however, that they had lived in Ireland for four years, on average, and reported that they felt happy about their stay in Ireland. They seemed to have been exposed to their native language more than to English in Ireland, using it with their families, numerous Polish friends, and also at work. Likewise, the one child whose scores were low for both L2 perception and production reported more Polish language use in his life in Ireland and having almost no Irish friends, although he had lived in Ireland for three years when the study was conducted.

Most importantly, the two NPI groups differed in their perception of similarities between L1 and L2 sounds. On average, the similarity judgements of 'high accuracy' learners clustered around the value of 3 (on a scale from 1, meaning "no similarity", to 7, meaning "identical"); i.e. they did not assimilate L2 sounds into L1 categories readily, although they perceived that there was a level of similarity between certain L2 and L1 vowels. In contrast, 'poor accuracy learners' among the NPI adult and child L2 learners in this study rated the similarity of the tested vowels conservatively, at around a value of 3.5., suggesting that they were moving along the scale from separating the sound systems of the two languages totally (two adult L2 learners reached a score of 2 for the overall fit index score of the tested vowels) to perceptions of high similarity between the two languages (one adult's overall fit index score equalled 5). In contrast, only one child L2 learner from the 'good accuracy groups' rated similarity between the L1 and L2 vowels at around the value of 2, and none rated similarity of the vowels above the value of 4.

5.3. Summary

The findings reported in this chapter indicate that perception and production of L2 vowels are influenced by age of L2 learning, by (quality and quantity of) L2 experience and, to an extent, by perception of similarities between L1 and L2 sounds. These results suggest that all three factors affect L2 speech learning. Individual differences for the participants in this study showed further age effects relative to the perception and production accuracy of L2 vowels, and suggested possible relationships between performances on the three tasks undertaken in the study.

In the following and final chapter of this thesis, the findings of the study are discussed, together with implications and suggestions for further research. Conclusions then complete the thesis.

Chapter 5

Discussion and conclusions

1. Introduction

The main aim of this study was to gain a better understanding of the effect of age, native language and L2 experience on the ability to acquire L2 sounds. More specifically, this study tested the hypothesis of Flege's SLM (1995), which proposes that children may be more successful L2 speech learners than adults because their L1 sound system is still evolving and therefore affects the formation of new L2 sound categories less. On the basis of their purportedly assimilating L2 sounds to L1 categories less than adults do, children are predicted to be better able to perceive and produce L2 sounds accurately. Previous research testing this fundamental hypothesis of the SLM model has been scarce, although two studies by Baker *et al.* (2002, 2008) have addressed the issue in the context of Korean bilinguals living in the U.S. Yet, as the author of the model himself has repeatedly emphasized (e.g. Flege and MacKay, 2010), more research is needed to ascertain whether L2 children indeed perceive the relationship between L2 and L1 sounds in a different manner. Such a finding would greatly add to our understanding of child-adult differences in the acquisition of L2 speech.

In the next section, a concise summary of the findings related to each of the three tasks of the study is presented, followed by the discussion of the findings and suggestions for further research.

2. Summary of findings

The results of this study indicate that child L2 learners do perceive the relationships between L1 and L2 sounds differently, and that judgements of perceptual similarity, at least to some extent, predict and explain the L2 speech

perception and production accuracy of these learners. However, other factors, such as native language phonology and (quality and quantity of) L2 experience also determine to what extent L2 sounds may be perceived and produced with native-like ability.

2.1. Cross-language phonetic similarity task

The cross-language phonetic similarity task established that Polish and (Irish) English vowels can be perceived on the basis of at least two types of relationships: that of a one-to-one relationship and that of a two-to-one relationship. For example, English /ɛ/ was perceived on a one-to-one basis with respect to Polish /ɛ/, and English /i/-/ɪ/ on a two-to-one basis with respect to Polish /i/. The English vowels that were mapped onto Polish vowels on the basis of a one-to-one relationship were found to be easier to learn because of their similar categorical relationship to L1 vowels, whereas vowels perceived on a two-to-one basis were shown to be more difficult for the L2 learners to acquire.

In addition, it was found that cross-language similarity perception is influenced by both age of L2 learning and L2 experience. Child L2 learners living in Dublin were less likely than their adult counterparts to perceptually associate L1 and L2 sounds, as manifested by their lower goodness-of-fit ratings for the English vowels /i/, /ɪ/, /æ/, /ɛ/, /ɔ/ and /əʊ/. Moreover, child L2 learners differed from adult L2 learners in their mapping of the specific L2 vowels /ɪ/ and /ɔ̈/ into L1 categories. On the other hand, the child L2 migrant learners did not significantly differ from the non-immersion child L2 learners in their perception of cross-linguistic similarity in any of the tested vowels, suggesting that children may be more accurate in perceiving differences between L1 and L2 sounds, regardless of their learning experience with the target language. Finally, significant differences were found between adult L2 migrant learners and adults without any immersion

experience, who generally judged all the tested L2 vowels as being very different from any L1 sound.

2.2. Categorical discrimination task

The categorical discrimination task revealed that L2 perception abilities among the participant groups in this particular study were also influenced by age of L2 learning and L2 experience. Whereas neither group of Polish child learners discriminated the L2 contrasts significantly differently from the Polish adult learners, L2 child learners with immersion L2 experience perceived four of the five L2 vowel pairs as accurately as did age-matched native speakers. Adult L2 migrant learners were, in turn, accurate in the discrimination of only those contrasts that were considered 'non-confusable' in respect of L1 categories. As regards the L2 experience effects, these were documented for the perception of most of the tested L2 contrasts. Thus, the results of the categorical discrimination task supported the prediction that L2 learners with a three-year-long immersion experience would discriminate L2 contrasts more accurately than L2 learners without such L2 learning experience.

2.3. Delayed-repetition task

The results of the delayed repetition task showed that child L2 migrants were more accurate than were adult L2 migrants in the production of those L2 vowels that they mapped differently, and that they were native-like when producing six of the eight L2 vowels tested in the task. For their part, adult L2 migrants were not significantly superior in their production of L2 sounds when compared to adult learners without immersion L2 experience, performing in a native-like manner in the task only when producing three of the 'non-confusable' L2 vowels. Thus, the results of the delayed repetition task supported the prediction that L2 child participants in this study would become superior in their L2 production. However, the predictions about L2 production abilities of the L2 adult participants in the study

were not borne out, because the two groups of adults did not significantly differ in their L2 vowel production.

3. Cross-linguistic perception: the age factor

The main goal of this study was to determine cross-language perception of Polish and specific Irish English vowels for both Polish children and adults. In addition, the study sought to determine whether judgements of cross-language similarity differed depending on age of L2 learning. Such a finding would indicate whether perception of cross-language similarity can explain differences documented in the eventual L2 perception and production abilities of children and adults.

The child L2 learners in this study were less likely than were adult L2 learners—albeit to statistically non-significant levels—to perceptually associate most of the tested L1 and L2 vowel sounds. Moreover, children differed from adults in their mapping of the /I/ and /ɔ̈/ vowels into relevant L1 categories, which suggests that the perception of these specific L2 sounds was also influenced by age of L2 learning. As Flege (1995) and Baker *et al.* (2002, 2008) proposed, young L2 learners may be more reluctant to assimilate L2 sounds into L1 categories because their L1 sound system is itself still evolving. As a result, child L2 learners may treat non-native sounds more independently from their L1 categories. Hence, their lower fit index scores for the majority of the tested L2 vowels in this study. The /u/ and /ʊ/ vowels, in turn, were judged to be more similar to corresponding L1 categories by children in this study, which might at first seem contrary to the assumption discussed above; however, it may also be the case that the children perceived these vowels in relation to their newly formed L2 categories rather than in relation to L1 categories. As Trofimowich, Baker and Mack (2001) showed, experienced L2 learners are likely to form new L2 categories for L2 sounds that do not occur in their native language, and 'merged L1-L2 categories' for highly similar L1 and L2 sounds. The latter case describes a situation whereby L1 categories are

accommodated to process similar L2 sounds. Such L2 sounds would then be perceived as good exemplars of the merged L1-L2 categories. Since the NPI children in this study were shown to use English in a variety of contexts frequently, i.e. they probably experienced rich L2 input in the course of their three years of residence in Ireland, they might have indeed established new L2 sound category for the novel sound /ʊ̈/, and merged L1-L2 category for the similar L2 sound /u/. Hence, one might argue, the Polish migrant children's relatively high similarity judgement scores for the two L2 vowels. In contrast, the NPI adults, being 'experienced L1 users', might have perceived similarities between the tested L2 and L1 vowel sounds solely in respect of their established L1 sound categories. This tendency towards reliance on stable L1 perceptual representations was even more apparent in the performance of the Poles without any immersion L2 experience, who strictly differentiated between the two sound systems, showing a kind of psychological bias towards perception of similarities between the two languages. However, as was also shown in this study, cross-language perception does develop in adult learners as a result of naturalistic experience with the L2. After about three years of residence in Ireland, NPI adults were found to be more accurate in their perception of similarities and differences between L1 and L2 vowels than were NPP adults. This is, in a broader sense, in agreement with the fundamental claim of the SLM that the learning capacities for L2 acquisition remain available across the life span (Flege, 1995).

One possible critical perspective on the inference that children are less likely than adults to perceptually assimilate L2 sounds to L1 categories would be that children may simply be less able than adults to perform cross-language perceptual tasks (cf. Baker *et al.,* 2002, 2008). Perhaps the use of other methods of measuring perceptual relationships between L1 and L2 sounds might have been more revealing and appropriate in this study. For example, Cebrian, Mora and Aliaga-Garcia (2010) have recently demonstrated the advantage of combining a

rated discrimination task together with the perceptual assimilation task in reliable assessments of cross-linguistic perception. Baker *et al.* (2008) have suggested that more fine-grained rating scales should be used to make it possible to detect significant differences between children's and adults' perceptual goodness ratings. Also, Strange (2007) has advocated the use of an ordinal rather than interval scale of quantification in Lickert-scale judgements of similarity in this type of research. Finally, more direct techniques, such as those used in neuro-imaging studies, would probably have revealed greater nuances between the children's and adults' perception of cross-linguistic similarity (Sebastián-Gallés, 2005). More research is clearly needed to determine which (combination of) methods might be best employed in studies that set out to investigate the effect of age in cross-linguistic perception.

Nevertheless, an examination of the data reported in this study still suggests that the child L2 learners perceived the discrepancies between L1 and L2 sounds differently from the adults. First, the NPI children did not provide a higher number of inexplicable or inconsistent answers than the NPI adults, and therefore their overall lower cross-language similarity judgements can be considered valid reflections of the development of their sound system for the two languages. Second, the NPI children perceived greater similarities between the L2 /I/ and /ɔ̈/ vowels and L1 /ɨ/ and /u/ vowels, respectively, because they had presumably formed a merged L1-L2 category for the former L2 sound, and a separate L2 category for the latter sound. It is likely, however, that this L2 category still differed in some way(s) from the representations that monolingual speakers of the relevant languages develop (Flege, 1995). Third, the NPI children managed to distinguish between pairs of L2 sounds that are acoustically and perceptually similar to single L1 categories, such as /i/-/I/ and /ɔ/-/əʊ/, to a greater extent than the adults did, further suggesting greater perceptual sensitivity towards degrees of a

match between sounds. Finally, children without any L2 immersion experience performed more accurately than their adult counterparts at the cross-language perception task, suggesting that children aged around 12 have a greater capacity for performing such a task. In addition, this result may provide a general indication that children are more accurate cross-language perceivers than adults. These findings together indicate that at least one difference between child and adult naturalistic learners may be that child L2 learners are less likely to perceptually assimilate L2 sounds to L1 categories.

4. Cross-linguistic perception and L2 perception

Another goal of this study was to determine whether age differences found in cross-language perception would predict L2 learners' discrimination abilities. In other words, it was of interest in this study to find out whether L2 children, given their more accurate ability to perceive differences between L1 and L2 sounds, would also be better able to perceive differences between different L2 sounds. The results of the categorical discrimination task in this study revealed that, overall, neither group of Polish child learners discriminated the tested L2 contrasts significantly differently from the Polish adult learners; however, when compared to age-matched native speakers on the discrimination of individual L2 contrasts, children with naturalistic L2 learning experience perceived four of the five L2 vowel pairs to native-like levels. These L2 contrasts included vowel pairs across the range of tested category assimilation patterns. Adult migrants, for their part, performed in a native-like manner in the discrimination of three of the five tested L2 contrasts, all of which included L2 pairs falling within the Two-Category or Category-Goodness assimilation patterns. In other words, the challenging Single-Category assimilation pattern did appear to hinder the adult learners' ability to discriminate between L2 vowel pairs that were perceived as good members of a single L1 category. In addition, an investigation of individual differences revealed that many more migrant

children than adults discriminated all the vowel contrasts within one standard deviation of the performance noted for age-matched native speakers.

The results of this study agree with previous research documenting the fact that, as they start to learn an L2, children and adults may perceive L2 contrasts comparably well, but that eventually children outperform adults in L2 perceptual tasks as their experience with the target language grows (Baker *et al.,* 2002, 2008; Tsukada *et al.,* 2005). It is striking that after three years of residence in the L2-speaking country, the migrant children in this study had mastered the discrimination of such difficult L2 contrasts as /ɔ/-/əʊ/ and /i/-/ɪ/. One recalls, however, that these were also those L2 pairs that the NPI children perceived more accurately than the NPI adults in the cross-language similarity task. Their fit index scores for the vowels concerned showed a greater distinction, suggesting that the child L2 learners had formed, or had been forming, separate L2 categories for the vowels in the pairs, rather than subsuming them under an existing L1 category. In line with what Flege (1995) predicts, establishing separate categories for L2 sounds might have helped the children to discriminate these and the other tested L2 contrasts more accurately.

Yet, the discrimination of the /i/-/ɪ/ vowel contrast was generally difficult for all Polish participants in this study, and, in fact, for some native speakers as well. One explanation for this result may be that the presented realization of the /i/-/ɪ/ contrast in the bVt context was not distinct enough. An acoustic examination of the stimuli spoken by a young Irish female revealed that the duration of the /i/ vowel was 136 milliseconds, while the duration of the /ɪ/ vowel was 81 milliseconds. The difference in duration of the vowels thus corresponded to a standard ratio of long to short English vowels (approximately 1.5:1). Presumably, Polish learners of English, who have been shown to base their discrimination of the English contrast primarily on duration, rather than on spectral differences (Bogacka, 2004), might have lacked enough acoustic cues for its discrimination, and may have distinguished

between the L2 vowels at about chance level. A second explanation may be that the task was simply difficult to perform. However, all the participants underwent a pre-test session (see Chapter 3 for details), which ensured that they understood the task. Only those participants who responded accurately and confidently in the pre-test session were allowed to continue with the actual categorical discrimination task. Also, the fact that one of the contrasts, the /ɪ/-/ɛ/ vowel pair, was discriminated to near ceiling levels by all the participants suggests that both child and adult participants were able to perform the task as intended.

Finally, another factor probably contributing to the children's more accurate discrimination of the individual tested contrasts relates to their greater exposure to native-speaker input. As shown in the previous chapter, the NPI children reported more intensive contact than the NPI adults with their English speaking peers, which might have created pressure for them to learn to cope with lexical distinctions involving even those L2 vowel pairs that were perceived as good instances of a single L1 sound. Using their L2 frequently, the NPI children might have acquired a larger L2 lexicon containing many minimally contrasting words, which, in turn, might have supported their more accurate discrimination of the L2 vowels (Best and Tyler, 2007). Future research into the development of L2 speech perception in children and adults may thus need to systematically control for such lexical variables as word frequency, subjective word familiarity, and lexical neighbourhood density (cf. Baker *et al.,* 2008).

In any case, the results of this study suggest that children are more accurate in cross-language similarity perception than adults, and that this ability, together with rich L2 experience, may predict and explain their more accurate categorical discrimination of L2 sounds.

5. Cross-linguistic perception and L2 production

The final goal of this piece of research was to determine whether the ability to perceive differences between L1 and L2 sounds also predicts L2 production skills. In other words, it was also of interest in this study to find out whether child L2 learners, given their more accurate performance at the cross-language perception task, would produce specific L2 vowels more accurately than adult L2 learners.

The results of the delayed repetition task showed that the child L2 migrants were indeed significantly more accurate than the adult L2 migrants in the production of those L2 vowels that they mapped differently, i.e. Irish English /ɔ̈/ and /ɪ/. As hypothesized above, it is likely that the children had formed new categories for these vowels, and for this reason produced the sounds with good intelligibility. Another reason for the children's significantly more intelligible production of the /ɔ̈/ vowel might be related to the difference in their previous L2 learning. While the NPI adults had had some experience learning their L2 in the context of British or American English, the NPI children usually had come to Ireland without any or much formal L2 learning experience at all. This fact might have created an advantage for the children in the production of this Irish English vowel sound: they did not need to change their representation of the L2 sound, as might have been the case for the adults, who would have been taught to perceive and produce the vowel as an open-mid back unrounded vowel /ʌ/. Put differently, when acquiring the Irish English /ɔ̈/, the children's task might have been 'only' to establish a new category for the L2 sound, whereas the adults might have first needed to tune into the new acoustic characteristics of the sound, shift its perceptual mapping, and only then attempt to translate this new information into their production of the segment (cf. Escudero, 2005). The high diffuse confusion patterns in the adults' productions of the vowel point to this direction of reasoning.

In addition, the migrant children in this study were native-like in their production of six of the eight L2 vowels, and individual analyses revealed that a much higher proportion of the child participants than of the adults fell within the group of 'good producers'. Moreover, adults with a comparable length of residence in the L2-speaking country did not manifest a realization of the tested L2 sounds that was significantly better that that of adults without such a learning experience. They reached native-like accuracy in producing only three of the eight tested vowels: /i/, /ɛ/ and /æ/. It is to be recalled that these sounds were also those that were perceived by the adult learners as good exemplars of the corresponding native categories. This finding is in line with what Best *et al.* (2001) called the 'native language similarity effect'. This notion suggests that L2 sounds that are perceived as good exemplars of the native language categories are likely to share similarities in gestural realization, acoustics, phonotactics and other properties, which may aid their acquisition. In contrast, poor-fitting L2 sounds are likely to be perceived poorly and to constitute a more challenging learning task. Perhaps any improvement in learning to pronounce these sounds was so subtle in the adult L2 learners that the evaluation used in this study (intelligibility ratings) did not detect it. A study by Munro and Derwing (2008) reported a similar concern with respect to beginning adult L2 learners of English from Slavic backgrounds, who resided in Canada.

Overall, the results of this study agree with previous research on age effects in L2 production, indicating that with the same length of residence in the target language country, children generally outperform adults in producing L2 sounds (Aoyama *et al.*, 2008; Baker *et al.,* 2002, 2008; Jia *et al.,* 2006; Piske *et al.,* 2002; Tsukada *et al.,* 2005). One possible explanation of this early advantage in L2 speech production is that children, as shown in the cross-language perception task, may be less likely to identify L2 sounds with L1 sound categories, and therefore more likely to produce them more authentically (Baker *et al.,* 2002; 2008).

Alternatively, children may receive richer L2 input and seek out such input more, which may equip them better for the attainment of native-like L2 production. Jia and Aaronson (2003) showed that early learners commonly enjoy L2 input that is more abundant, intensive and varied than that enjoyed by late arrivals. In a similar vein, Moyer (2008) argued that early exposure to an L2 is related to a compound of interacting psychological, social, and cognitive factors. For example, children who use their L2 more with native speakers may be likely to be more motivated towards the L2, which, in turn, might feed back into their identification with the language and culture of the host country. Being enrolled in target language schools may also expose them to more phonological correction and feedback, leading to more advanced L2 production skills and presumably a greater sense of attainment, keeping their motivation in relation to frequent L2 contact high. Dörnyei (2005) further adds to this complexity by proposing that successful L2 learners appear to reconceptualise their 'ideal L2 selves' and 'ought-to L2 selves' such that they visualize themselves as advanced users of the target language and, provided this ideal is in harmony with what the L2 learners believe their significant others expect of them, such a constellation may aid their successful L2 acquisition. Indeed, qualitative analyses of the data collected from the high achieving Polish children in this study indicated that these learners' ambitions were often directed towards a career and life in which English language would be used or needed—such as a career as an English teacher, a translator, a programmer, or a desire to stay in Ireland permanently. Further, as reported by the children both in the questionnaires and follow-up interviews, their parents seemed to have extremely high expectations with regard to their future and their English skills. A vast majority of the participating children reported an active everyday encouragement on the part of their parents to make use of multimedia in learning English, and to speak English with their peers as much as possible. The Polish parents were reported to stress constantly the importance of English for their children's future and for good

job prospects. Although these data are quite insightful, it is difficult to offer a reliable interpretation of the data in respect of the children's superior production of L2 speech in this study. As MacIntyre, Mackinnon and Clément (2009) point out, it may be impossible to measure the concept of possible selves in a meaningful and reliable way. In this study, it was observed that all the participants, regardless of their L2 performance, were highly aware of the importance of learning English for their lives, present and future, which is not surprising considering their migrant realities within today's EU.

A further, not incompatible, reason for the Polish children's superior L2 speech production might have been that their richer L2 input was related to their experience with the L2 lexicon. Baker and Trofimowich (2008) showed that adults exposed to the L2 in a naturalistic environment for about one year were affected by lexical familiarity and frequency in their production of L2 vowels significantly more than were child L2 learners. In particular, this held true for vowels that were dissimilar from any of the learners' L1 sounds. The authors speculated that thanks to the greater and richer exposure to native-speaker input, children might surpass adults in their progress through L2 word learning; as a result, their L2 production might show progressively less influence of lexical and segmental factors.

Finally, the reason why NPI children in the current study were better at L2 sound production than were the NPI adults might be that in the delayed-repetition task used to determine their production ability, the children might have benefited from the auditory prompts more than the adults. It has been noted that children may, in fact, have a better ability for mimicry than adults (Tsukada *et al.,* 2005). This possibility, however, would only further point to children's superior ability to translate their accurate perception of what they hear into accurate production of it.

To summarize, the child L2 learners in this study were more likely to perceive differences between L1 and L2 sounds and used the L2 with their English-speaking peers more, which, in turn, may explain their superior production of L2

vowel sounds. The adult L2 learners, in contrast, did not seem to progress in the production of most of the tested vowels after three years of migration experience in the L2-speaking country.

6. Age-related differences in L2 speech learning

In this study, age of L2 learning was found to influence cross-language similarity judgements, and also L2 perception and production. It was demonstrated that perception of similarity between L1 and L2 sounds predicted L2 child learners' perception and production of the L2 sounds. However, the ability to distinguish accurately between L1 and L2 sounds did not seem to be associated with L2 adult learners' production of L2 segments. In contrast, L2 adults' discrimination of L2 sounds and perception of cross-language phonetic similarity did appear to be related. This finding partially corroborates the results of Baker *et al.*'s (2008) study with Korean-English bilinguals, who resided in the U.S. for about one year. The authors speculated that children are probably more successful L2 learners because their abilities for perceiving differences between L1 and L2 sounds and for L2 production seem to be closely related, while in older learners these abilities are associated loosely. This study points in the same direction from a different learning environment: that of migration, and that of a three-year-long residence in the L2-speaking country. Where the two studies disagree is in regard to the relationship between cross-language similarity perception and L2 categorical discrimination. In this study, the two abilities were related in both child and adult L2 learners. One might speculate that this finding may be related to the nature of the perceptual tasks. Although the perception of differences between L1 and L2 sounds, and between L2 sounds, might not be qualitatively comparable, it is likely that the same perceptual mechanisms are used in making judgments of phonetic similarity and categorical discrimination. In this study, the two abilities were found to be related closely across age groups. In contrast, cross-language similarity perception and L2

production are likely to be less directly related, considering that the two skills—one involving motor control and the other auditory processing—may be controlled by different mechanisms. The specific learning experience of children, both in terms of their previous and current language learning, may bring the two skills more closely together in child L2 learners. In any case, the findings of this present research and the Baker *et al.* (2008) study demonstrate that the SLM (1995), relating cross-language similarity perception to L2 speech learning, offers a valid account of child–adult differences in L2 learning.

As expected, this study also demonstrated a compounded effect of L2 experience in L2 speech learning. Since, as Flege (2008) noted, it is almost impossible to measure input effects on L2 acquisition in a reliable manner, it is hard to state exactly what kind of L2 input was at play in the L2 speech learning of the participants in this study. Yet, qualitative analyses of this and other studies suggest that L2 input which is massive, coming from native speakers of the target language and diverse contexts, aids advanced acquisition of L2 speech. Indeed, those L2 learners in this study who used English with their friends at school or at work on an everyday basis were also those who performed highest in the language tasks. Further, and similarly to what has emerged from previous research, formal phonological training seemed to play a role in adult L2 speech learning in this study (see Bongaerts *et al.,* 1997; Cebrian, 2006; Moyer, 1999). This finding might be further interpreted as a support for the SLM (1995) prediction that those L2 learners who can perceive differences between L1 and L2 sounds, i.e. assimilate L2 sounds into L1 categories less, because they were trained to attain to subtle phonological differences between the two languages, can achieve native-like accuracy in L2 speech performance.

Another striking finding of this study is that that the effect of age may not be separated from the effect of proficiency level. We saw that the qualitative analysis of the data presented here revealed that the high-performing children were highly

proficient bilinguals. Recent imaging studies have offered one possible explanation for such effects: "when proficiency is high, the prevailing pattern of languages acquired at different ages is one of overlapping rather than separate neural circuitry underlying L1 and L2 performance" (Wattendorf and Festman, 2008, p.6). This would further suggest that the highly proficient L2 learners' performance was a reflection of the state of their L1 and L2 category formation, while the L2 learners of low proficiency in the target language kept the sound systems of their two languages separate, leading to a unidirectional L1->L2 influence on these learners' L2 speech learning. However, this avenue of research is still rather inconclusive, and thus more research is needed to address the question of the neurological dimension of L2 processing by children and adults. The findings from such research would also aid the debate on the effects of neurological maturation in L2 acquisition.

Overall, the age of onset was shown to be a significant predictor of L2 vowel sound learning in this study. A series of correlation analyses reported in the previous chapter showed that the younger the learner at the time of arrival in Ireland, the more accurately that learner performed in L2 vowel perception and production. This finding may be interpreted as being in line with the notion that L2 development does not start or finish at a particular moment during L2 learners' maturation, but continues, given appropriate continuing input, to develop across the lifespan. This view is also compatible with explanations for cases of highly successful late L2 learners.

Polish adults who came to Ireland after 2004 often expressed a wish to learn to speak English fluently and to native-like levels. They even formulated this ambition as one of the decisive factors in choosing Ireland as a destination. The results of this study suggest that within a relatively short stay in the target language country, Polish adult migrants managed to advance their perception of English significantly, which is also likely to lead eventually to their more accurate L2

production (Flege, 1995; Rochet, 1995). As for Polish children and their English-language ability, they benefited from the naturalistic L2 experience to such an extent that their perception as well as production of diverse (Irish) English vowels compared to that of native speaking children.

Taking these findings together, therefore, the process of L2 speech learning seems to be influenced by a variety of factors, from age of L2 learning, native language phonology, to quantity and mainly quality of L2 experience. The effect of native language phonology, as the analysis of individual L2 segments in this study shows, can be especially pervasive in learning certain L2 sounds, even for children with several years of stay in the target language country. The interesting finding of this study, situated within a specific context of EU migration, however, is that the use of native language was not found to be a significant predictor of L2 speech perception and production in child L2 learners. The NPI speakers reported frequent and extensive contact with their L1 in their everyday life in Ireland, including NPI children who enjoyed opportunities to use their L1 at school as well as in a Polish weekend school. Furthermore, frequent flights to Poland, summer holidays in their home country and communication via the Internet (e.g. Skype) with their family members and friends back in Poland were commonplace. This would suggest that despite such exposure to their L1, child L2 learners might not be affected by L1 use during their L2 speech learning to the extent suggested by numerous studies with early L2 learners (Flege and MacKay, 2004; Flege, MacKay and Meador, 1999; Guion *et al.,* 2000; Piske *et al.,* 2002). One reason for this might be that this study looked at L2 phonological acquisition of children as they were learning their L2, rather than in retrospect. The children's inevitably less extensive experience with the use and processing of the native language sound system, compared with adults and even early L2 learners who continue to use their L1 often, may have led to a weaker interference with their L2 speech learning. However, individual analyses in this study did suggest that, in the case of some L2 sounds, such as the specific

Irish English vowel /ɔ̈/, those children who were able to produce the segment to native-like levels were also those who reported speaking their native language in Ireland less. Another explanation might be that at least some children in this study became dominant in their L2, or felt equally comfortable using their L1 and L2, and therefore no measurable L1 effects could be detected (Flege, 2003a; Jia and Aaronson, 2003; Grosjean, 1982).

7. Suggestions for further research

The primary aim of this study was to explore the effect of cross-language similarity perception on the L2 speech learning of children and adults. The study demonstrated that cross-language perception indeed partially predicts and explains the successful L2 perception and production of child L2 learners. Since previous research has paid little attention to direct comparisons of child and adult L2 speech learning, and cross-language perception in particular, more studies are clearly needed to further test the SLM (1995) hypothesis on the effect of L1 sound system development in relation to L2 phonological acquisition. Speech perception studies have primarily focused on analysing infants and adults, despite the evidence that significant changes occur during childhood in terms of how the native language is perceived (Baker *et al.,* 2008; Hazan and Barrett, 1999; Johnson, 2000). It is important to investigate further how these changes impact on L2 learners' perception of similarities between L1 and L2 sounds. In this regard, the challenge remains as to the most appropriate ways of measuring cross-language perception. According to Sebastian-Gallés (2005), "future research will have to use all available methodological tools—only joint efforts including both behavioural and brain-based measures (as well as computer simulations) will make it possible to fully understand the way we perceive foreign languages" (p.561). A fascinating new avenue of research which might further help refine measures of cross-language phonetic similarity may be that being conducted into language-specific phonetic

settings, investigating language-specific configurations of our vocal apparatus (Mennen *et al.*, 2010).

In this current study, only limited stimulus material was employed. It is important that further studies expand on other phonetic, phonotactic and prosodic contexts, segments, and suprasegmental features to investigate the effect of cross-language perceptual similarity on L2 speech learning. Speaker variation and processing demands could also be further manipulated in order to approximate more closely natural phonological processing and learning. In addition, a longitudinal design would be especially valuable in such investigations; it could systematically examine whether changes in cross-language similarity perception lead to changes in L2 speech learning of diverse L2 learners.

7.1. Implications for PAM and SLM

The results of this study have several implications for the two L2 speech learning models tested here. First, the hypotheses of the SLM (1995) were supported in this study of migrant L2 learners. Children perceived the similarity between L1 and L2 vowel sounds differently from adults, and also, they were more accurate in their perception and production of the tested L2 vowels. This finding is significant for L2 speech research, since it provides a possible explanation for why younger L2 learners are commonly more native-like in their L2 performance than are adults. Second, the predictions of PAM (1995) were also borne out in this study, both for experienced L2 learners and for child L2 learners. As with Guion *et al.* (2000) and Baker *et al.* (2002, 2008), it has been shown that the model accurately predicts the development of L2 speech perception. In particular, when both members of an L2 contrast were perceived as good exemplars of two separate L1 categories, L2 learners' discrimination of the contrast was very good. On the other hand, those L2 contrasts which were perceived as good members of a single L1 category were the most difficult to learn by all learners across age and L2 experience. Third, one finding of this study was that L2 contrasts which were

perceived as unequally good members of a single L1 category were discriminated well; nevertheless, they were produced inaccurately. To expand PAM in terms of incorporating predictions of production accuracy could make the model suitable for explanations of the whole process of L2 speech learning, possibly also shedding some light on the question of the relationship between L2 perception and production abilities. Fourth, although a systematic investigation of lexical effects on L2 speech learning was beyond the scope of this study, the results both of the perception and the production tasks utilised in this study indicated that the children's presumably greater familiarity with many minimally contrasting L2 words aided their accuracy in L2 performance. Therefore, both SLM and PAM might consider including the factor of L2 lexical development as an explicit component in their theory building. Fifth and finally, qualitative data analyses carried out within the framework of the L2 speech models, such as those conducted in this study, and longitudinal in nature, might bring SLM and PAM closer to the most recent perspective of L2 learning as a dynamic and nonlinear process. In this view, during L2 learning, initial conditions and "attractor states" might be trend-setting for some time, but the learning process might be more accurately viewed as too complex to accurately predict, given the variety of interacting "limited resources" involved (De Bot, 2008; Lowie, 2010).

8. Conclusion

The main goal of this study was to determine whether children are more likely than adults to perceive discrepancies between L1 and L2 sounds, and whether this ability might account for their more accurate L2 perception and production abilities. The results of this study suggest that children indeed are less likely to assimilate L2 sounds into L1 sound categories, indicating that the interaction

between the native and non-native phonetic systems of child and adult L2 learners forms at least one source of child-adult differences in L2 phonological acquisition.

As bilingual children are in the process of building a phonetic system in which new categories are being formed for all their languages, they are more likely than adults to create separate and/or merged sound categories for their L1 and L2. Consequently, children are commonly better perceivers and producers of an L2, although not necessarily native-like. This is because their perceptual mappings are presumably based on the amount and quality of linguistic input, which will always differ for individuals with different mother tongues. The kind of L2 input to which children are typically exposed and which they seek out, however, is likely to support their learning of L2 sounds to advanced levels. Thus, this study represents one possible explanation for child-adult differences in L2 speech learning, and adds to our growing understanding of how L1 and L2 languages are organized in bilingual speakers.

Finally, from the learner's prospective, the results of the present study point to directions for (adult) L2 learners to consider in identifying segments that are likely to pose a learning challenge and that might require focused instruction. This study may also serve as encouragement for all EU migrant learners and families who arrive in an L2-speaking country for a medium-long stay in the hope of, among other language areas, improving the way they produce the target language. The results are positive for everyone who pays attention to phonetic similarities and differences between sounds, and who enjoys interacting in their languages, regardless of how old they are upon their arrival in the L2-speaking country.

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Appendix 1

Anglia Placement Test

Anglia Examination Syndicate Limited

Chichester College ENGLAND

A Company Registered in England: Company Nº 2046325

INTERNATIONAL ENGLISH LANGUAGE / BUSINESS EXAMS FOR SPEAKERS OF OTHER LANGUAGES

PLACEMENT TEST
PART ONE

Mark the *answer sheet* with the correct letter. **Do not write on the test paper.**

1. How many stars? * * * * * * * * * * * * *

A. eleven B. twelve C. eighteen D. thirteen

2. Find the odd one out.

A. blue B. listen C. read D. write

3. Find the odd one out.

A. in B. behind C. under D. flower

4. Find the odd one out.

A. you B. yes C. he D. they

5. My brother is eleven years old . . . . . September.

A. on B. at C. in D. to

6. Jane . . . . . playing tennis now.

A. has B. am C. are D. is

1

7. Which plural is *wrong*?

A. peaches B. children C. babys D. tables

8. What time is 5.30 ?

A. five thirty B. five and a half C. thirty past five D. five half

9. I always . . . . . the bus to school.

A. takes B. am taking C. take D. taking

10. . . . . does the film begin?

A. Who B. When C. Where D. What

PLACEMENT TEST
PART TWO

Mark the *answer sheet* with the correct letter. **Do not write on the test paper.**

11. What is the opposite of "hard"?

A. soft B. fast C. light D. poor

12. What is the opposite of "dirty"?

A. cheap B. lose C. clean D. back

13. The blue hat is his and the red hat is . . . . . .

A. our B. my C. us D. mine

14. Which word is the odd one out?

A. took B. went C. say D. made

15. Which plural is *wrong?*

A. women B. knifes C. butterflies D. mice

16. . . . . Sally finished her work yet?

A. Has B. Does C. Have D. Did

17. That is . . . . . meal I've ever eaten!

A. bigger than B. biggest C. the biggest D. bigger

18. There isn't . . . . . money in my purse.

A. some B. lot C. many D. any

19. The baby was born . . . . . 30th October.

A. in B. at C. on D. to

20. He . . . . . his boat when the storm began.

A. sails B. was sailing C. has sailed D. sail

21. I'd rather . . . . . in a restaurant than at home.

A. ate B. eating C. eat D. eaten

22. If your headache gets worse, ... the doctor.

A. I'll phone B. I phoned C. I've phoned D. I phone

23. You closed the front door, ...

A. didn't you? B. hadn't? C. aren't you? D. haven't you?

24. George is the one . . . . . is sitting at the back of the class.

A. which B. what C. where D. who

25. The old woman used to . . . . . very beautiful.

A. was B. be C. were D. being

PLACEMENT TEST
PART THREE

Mark the *answer sheet* with the correct letter. **Do not write on the test paper.**

26. What time does the plane take . . . . . ?

A. through B. up C. off D. to

27. I . . . . . my grandmother for two months now.

A. haven't seen B. not seeing C. didn't see D. aren't seeing

28. If I . . . . . French, I'd go and live in France.

A. speak B. spoke C. had spoken D. am speaking

29. Which word is the odd one out?

A. frightened B. afraid C. pleased D. worried

30. Which word is the *opposite* of 'dangerous'?

A. happy B. safe C. nice D. strong

31. This house . . . . . 500 years ago.

A. built B. has built C. building D. was built

32. My teacher made me . . . . . my work again.

A. doing B. done C. do D. did

33. I love cowboy films and . . . . . my brother.

A. so does B. also is C. so are D. also do

34. After . . . . . his meal, he went upstairs for a rest.

A. finish B. finished C. finishing D. finishes

35. The book wasn't very . . . . . and I never finished it.

A. interest B. interested C. interests D. interesting

36. I would have bought that coat yesterday if it . . . . . cheaper.

A. would be B. had been C. was D. has been

37. We have just had our living-room . . . . . .

A. redecorated B. redecorating C. redecorates D. redecorate

38. She is always cheerful and happy . . . . . her illness.

A. but B. despite C. however D. because

39. It's no use . . . . . angry with babies. They don't understand.

A. to get B. gets C. got D. getting

40. "Did you meet John?" asked Fred. / Fred asked us . . . . . John.

A. did you meet B. we met C. are we meeting D. if we had met

PLACEMENT TEST
PART FOUR

Questions 41-46. Read this short article taken from a newspaper and answer the questions below. Mark your answers on the answer sheet. **Do not write on this test paper.**

A couple celebrating their 25th wedding anniversary on the west coast came across a rare loggerhead turtle as they strolled along the beach one evening. The turtle is only the second to be found in British waters since 1993. John and Rachel Martin saw the 35 cm turtle being battered by waves, put it in a large baking tin and called the local aquarium. Jane Matthews, manager of the aquarium, says that originally the turtle, a female, was thought to be in good enough condition for immediate release, but experts now think it should be given more time to recover. The turtle will be released into the sea again, but the date for this has been postponed until the creature has grown stronger. Meanwhile, the number of visitors to the usually quiet aquarium has almost doubled as people queue to see the temporary exhibit in its specially converted tank.

41. How many turtles *other than this one* have been found near Britain in recent years?

A. none B. one C. two D. three

42. What were John and Rachel Martin doing when they found the turtle?

A. getting married B. swimming C. looking for turtles D. having a walk

43. What will happen to the turtle when it is stronger?

A. It will be given back to John and Rachel Martin. B. It will be kept by the manager of the aquarium. C. It will be allowed to swim away. D. It will be shown as a special exhibit.

44. Why is there so much interest in the turtle?

A. because of its size B. because it's uncommon C. because it's weak D. because it's female

45. Which word in the story means the *opposite* of 'permanent'?

A. temporary B. usually C. originally D. immediate

46. Which word in the story means the *same* as 'put off'?

A. converted B. battered C. called D. postponed

PLACEMENT TEST
PART FIVE

Mark the *answer sheet* with the correct letter. **Do not write on the test paper.**

47. I wish I . . . . . a smaller nose.

A. have B. am having C. had D. would have

48. Gold is . . . . . valuable, it is also beautiful.

A. too B. as well C. very much D. not only

49. It's high time . . . . . out my desk.

A. clearing B. I cleared C. to clear D. clears

50. You . . . . . better go to the bank with that cheque today.

A. had B. should C. will D. are

51. If I . . . . . you, I'd go the police.

A. am B. be C. were D. would be

52. The . . . . . of the pipe I need is 67cm.

A. longer B. length C. longest D. long

53. The . . . . . of China is about 1.3 billion.

A. population B. populated C. populate D. populating

54. I'd rather you . . . . . read my private diary!

A. don't B. can't C. didn't D. won't

55. I'm sorry the actors have gone. I'd love . . . . . met them.

A. would have B. I had C. having D. to have

56. Look! There's parcel on the step. It . . . . . left by the postman.

A. must be B. must have been C. should have D. should be being

57. The teacher wouldn't put . . . . . the student's poor work any longer.

A. up for B. into C. up D. across to

58. Never . . . . . had such a terrible evening in my whole life.

A. have I B. I've C. I did D. I

59. Claire's grandmother takes care . . . . . her when her parents are away.

A. to B. by C. for D. of

60. Neither David . . . . . his sister eat meat.

A. and B. nor C. also D. not

Appendix 2

Answer sheets

I. Cross-language phonetic similarity task

1a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

1b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->

They are not at all alike ☹ *They are a complete match☺*

2a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

2b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->

They are not at all alike ☹ *They are a complete match☺*

3a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

3b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->

They are not at all alike ☹ *They are a complete match☺*

4a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

4b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->

They are not at all alike ☹ *They are a complete match☺*

5a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

5b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<----------->

They are not at all alike ☹ *They are a complete match☺*

6a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

6b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<----------->

They are not at all alike ☹ *They are a complete match☺*

7a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

7b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<----------->

They are not at all alike ☹ *They are a complete match☺*

8a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

8b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<----------->

They are not at all alike ☹ *They are a complete match☺*

9a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

9b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<---------->

They are not at all alike ☹ *They are a complete match☺*

10a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

10b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<---------->

They are not at all alike ☹ *They are a complete match☺*

11a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

11b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<---------->

They are not at all alike ☹ *They are a complete match☺*

12a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

12b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7

<---------->

They are not at all alike ☹ *They are a complete match☺*

13a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

13b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->
They are not at all alike ☹ *They are a complete match☺*

14a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

14b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->
They are not at all alike ☹ *They are a complete match☺*

15a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

15b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->
They are not at all alike ☹ *They are a complete match☺*

16a What does this word sound like?

*b**i**ty* *b**y**ty* *b**e**ty* *b**u**ty* *b**o**ty* *b**a**ty*

16b How much is the English word (=the middle sound) like the Polish one?

1 2 3 4 5 6 7
<---------->
They are not at all alike ☹ *They are a complete match☺*

II. Categorical perception task

Which word is the odd one out?

1.	1	2	3	☺
2.	1	2	3	☺
3.	1	2	3	☺
4.	1	2	3	☺
5.	1	2	3	☺
6.	1	2	3	☺
7.	1	2	3	☺
8.	1	2	3	☺

Which word is the odd one out?

9.	1	2	3	☺
10.	1	2	3	☺
11.	1	2	3	☺
12.	1	2	3	☺
13.	1	2	3	☺
14.	1	2	3	☺
15.	1	2	3	☺
16.	1	2	3	☺

Which word is the odd one out?

17.	1	2	3	☺
18.	1	2	3	☺
19.	1	2	3	☺
20.	1	2	3	☺
21.	1	2	3	☺
22.	1	2	3	☺
23.	1	2	3	☺

Which word is the odd one out?

24.	1	2	3	☺
25.	1	2	3	☺
26.	1	2	3	☺
27.	1	2	3	☺
28.	1	2	3	☺
29.	1	2	3	☺
30.	1	2	3	☺

Which word is the odd one out?

31.	1	2	3	☺
32.	1	2	3	☺
33.	1	2	3	☺
34.	1	2	3	☺
35.	1	2	3	☺
36.	1	2	3	☺
37.	1	2	3	☺
38.	1	2	3	☺

Appendix 3

Protocol for the tasks administration

Once again, thank you very much for your time and help with our study.

The study has got three parts — the first two parts are looking at how you perceive/hear some English sounds, and the third part is about how you produce them. It is very important to know that this study does not look for right or wrong answers. Therefore, go by your first impression and spontaneous reaction when doing the tasks, please. They are all very easy to do, but if you have any questions at any moment, please, don't worry to ask.

Now let's start with ***the first task:***

On the computer screen, you can see six Polish words. First, I would like you to read the words, out loud, one by one. Please take your time and concentrate on how you produce the words — specifically, how the middle sound (marked in red on the screen) sounds to you. Can you please read the Polish words now?

On the computer screen, you can also see symbols for eight recordings. These are English words that I would like you to listen to—one by one—and tell me *which of the Polish words you have just read is similar to the one you are going to hear in English*. Also, I would like you to tell me *how much you think the English word sounds like the Polish word you selected* on a scale from 1 to 7. "1" means 'not similar at all' and "7" means 'a complete match'. Please use the whole scale, as necessary. Again, focus only on the middle sound, and not how the words begin or end. You can listen to the English words as many times as you wish, and you can also read the Polish words again, if you like. Now let us move to a short practice session. What do you think — which Polish and English words/ their middle sounds are most similar? How much do you feel they are similar? Can we now move on to the actual experiment? Any questions before we start? This time, please give your answers in the answer sheet.

The next task includes English words only. You will listen to three words pronounced by three different people. Your task is to say *which of the three words sounds different*. *Be careful though*; *there will also be cases when all three words are the same*. If you think that the first word is different from the other two, please circle number "1" in your answer sheet. If the second word is different, please circle number "2"; if the third one is different, please circle number "3"; and if you think that all three words are the same, circle the smiley face. Again, you can listen to the English words as many times as you wish. There will be a little break halfway through this task, but if you want to stop earlier, it is perfectly OK. Just let me know. Now let us move to a short practice session. Can we now move on to the actual task? Any questions?

Finally, ***the third task*** is very short and easy. You will hear a sentence and I would like you to repeat it. I will record this, if that is OK. Listen to the sentence and say it back to the microphone as if in a reaction: "And now I say_____ for you". There are 16 English sentences to repeat. Can we start now?

This was the last task. Well-done!

Debriefing and after-task semi-structured interview

Thank you very much again for your great help with our study. What we are looking at in this study is how languages are perceived and produced. We would like to know, whether, perhaps, there are differences between children and adults in the way they perceive English, when they are learning it as a foreign language; or how different people cope with learning the sounds of English after they have lived, for example, in Dublin, for some time. This is interesting for us because in this way we hope to better understand what happens in our mind when we learn languages and sounds of languages.

If interested, I will be happy to email you the results and we can discuss which of the tested sounds seem to have been especially challenging for you to perceive and/or produce. Perhaps, if you like the idea, I could also email you some materials; some links to websites, where you can listen to specific English sounds and sentences, and practise pronouncing them.

Overall, how did you find the tasks?

Do you think you knew/understood all the words used in the experiments?

Questionnaire — so you have lived in Dublin for ... Did you ever live in another

English-speaking country before coming to Ireland? You mention ...

Do you have any questions or comments before we finish?

Thank you very much again for your time and help.

After the session remarks:

1. How long?
2. Participant's attitude?
3. Was anyone present?
4. Were there any questions/moments that the participant did not seem to understand?
5. What were the questions/issues that the participant raised during the session?

Appendix 4

Stimuli for the perception and production tasks

Tested (Irish) English vowel sounds:

/i/	/I/	/ɛ/	/æ/	/ɔ/	/əʊ/	/u/	/ɔ̈/
beat	bit	bet	bat	bought	boat	boot	but

Polish key words used for the *Cross-language identification task*:

/i/	/ɨ/	/ɛ/	/a/	/ɔ/	/u/
bity	byty	bety	baty	boty	buty

An example of L2 minimal pair combinations (*beat – bit*) for the *Categorical discrimination task*:

beat – beat – beat	bit – bit – bit
beat – bit – beat	bit – bit – beat
bit – beat – beat	bit – beat – bit
beat – beat – bit	beat – bit – bit

Appendix 5

Categorical discrimination task: response distribution

Which word is the odd one out?	
1.	2
2.	1
3.	3
4.	☺
5.	1
6.	3
7.	2
8.	2

Which word is the odd one out?	
9.	☺
10.	2
11.	3
12.	2
13	☺
14.	☺
15.	2
16.	☺

Which word is the odd one out?	
17.	3
18.	2
19.	3
20.	3
21.	2
22.	3
23.	3

Which word is the odd one out?	
24.	1
25.	3
26.	1
27.	1
28.	1
29.	☺
30.	☺

Which word is the odd one out?	
31.	3
32.	1
33.	1
34.	2
35.	1
36.	1
37.	2
38.	☺

Appendix 6

Questionnaires

Background questionnaire

L2 speech perception and production study

Thank you for agreeing to participate in the Polish Diaspora Project funded by the IRCHSS. It investigates the Polish people living in Ireland from a number of perspectives. In this questionnaire we would like to ask you about ***your English language learning and use of Polish in Ireland.*** *Most of the questions can be answered by ticking (✓) one of the relevant boxes. In those cases where you need to write in an answer, you can use either English or Polish.*

You will need about 10 minutes to complete the questionnaire.

ID code: _____

Your contact with English

1. How old were you when you first learned English? _____
2. When you first learnt English, did you enjoy it?

☐ *Yes.* ☐ *No.*

3. (a) Are you taking any extra English classes now?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES:

(i) What kind of course is it? _____

(ii) How many hours per week? _____

4. How often is it the case that when you speak English it is with …

	very often	*often*	*sometimes*	*not often*	*never*
Irish native speakers?					
non-native speakers?					

5. Who are the Irish people you speak to? (*Tick more boxes if appropriate*)

my family	*my friends*	*my colleagues from work*	*people in shops, in the street...*	*other:*

6. How often do you use English in the following contexts in Ireland?

English use	*always*	*often*	*sometimes*	*not often*	*never*
with family					
with friends					
in your free time					
at work					

7. How much time a day do you spend on watching TV and listening to the radio/ music in English in Ireland?

more than 5 hours	*3 to 5 hours*	*1 to 2 hours*	*less than 1 hour*	*no time*

@ Your contact with Polish

8. What is the balance of your use of Polish and English in your everyday life in Ireland?

much more Polish	*more Polish*	*half and half*	*more English*	*much more English*

9. How often do you use Polish in the following contexts in Ireland?

Polish use	*always*	*often*	*sometimes*	*not often*	*never*
with family					
with friends					
in your free time					
at work					

10. How much time a day do you spend on watching TV and listening to the radio/ music in Polish in Ireland?

more than 5 hours	*3 to 5 hours*	*1 to 2 hours*	*less than 1 hour*	*no time*

Your language motivation and attitudes

11.How important is it for you to …

	very important	*important*	*neither important nor unimportant*	*unimportant*	*very unimportant*
speak English fluently?					
sound as native-like as possible?					

12. How easy do you find it to…

	very easy	*easy*	*neither easy nor difficult*	*difficult*	*very difficult*
learn English?					
understand Irish English?					

13. (a) Are there situations in which you feel uneasy speaking English?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, can you describe such a situation?

.....

14. (a) Do you like speaking English?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, can you say why?

(c) If your answer is NO, can you say why?

15. How satisfied are you with your English pronunciation?

very satisfied	*satisfied*	*neutral*	*dissatisfied*	*very dissatisfied*

16. (a) Have you ever received advice on your English pronunciation?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, can you describe the kind of advice?

.....

17. (a) In private, do you try and imitate the (Irish) English accent?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, what exactly do you do?

.....

18. How much would you like to become similar to the Irish people?

very much	*much*	*neutral*	*not*	*not at all*

19. (a) Overall, how happy do you feel living in Ireland?

very happy	*happy*	*neutral*	*unhappy*	*very unhappy*

(b) Can you say what makes you feel this way? *(Please give details)*

.....

.....

20. Can you please complete the following sentences? ☺

a/ Learning English is important for me because.....

.....

b/ What people who I respect think about English is that.....

.....

c/ Whenever I think of my future, I imagine myself.....

.....

@ General background

21. Gender: ☐ *male* ☐ *female*

22. Date of arrival in Ireland: ☐

23. Level of education attained:

☐ *primary* ☐ *vocational* ☐ *secondary* ☐ *tertiary*

24. Present job: .....

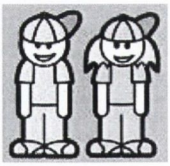
25. Other foreign languages besides English : *(Please, indicate <u>all</u> the foreign languages you have ever learned <u>regardless</u> of your present proficiency in them)*

☐ *German* ☐ *French* ☐ *Russian* ☐ *other:* ☐

Thank you very much for your help, time and ideas!

Background questionnaire

L2 perception and production study



Thank you for helping us with our project. It looks at Polish people, including children and teenagers like you, living in Ireland. We would like to ask you about ***your learning of English and use of Polish in Ireland.*** *Please, read the questions carefully and answer them by ticking (✓) one of the boxes. Sometimes you will have to write an answer in the boxes. You can use English or Polish for your answers. This is not a test, so there are no "right" or "wrong" answers. We are interested in how YOU see things.*

You will need about 10 minutes to answer the questions.

ID code: _____

Your contact with English

1. How old were you when you first learned English? _____
2. When you first learned English, did you enjoy it?

☐ *Yes.* ☐ *No.*

3. (a) Are you going to any extra English classes now? (for example, private lessons, an English course outside of school, extra English lessons in school)

☐ *Yes.* ☐ *No.*

(b) If your answer is YES:

(i) What kind of classes? _____

(ii) How many hours per week? _____

4. How often is it the case that when you speak English it is with …

	very often	*often*	*sometimes*	*not often*	*never*
Irish people, for example, other Irish children/teenagers?					
people who are not from Ireland?					

5. Who are the Irish people you speak to? *(You can tick more boxes)*

my family	*my friends*	*my teachers*	*people in shops, in the street...*	*other:*

6. How often do you speak English in the following situations in Ireland?

English use	*always*	*often*	*sometimes*	*not often*	*never*
with family					
with friends					
in your free time					
at school					

7. How much time do you spend watching TV and listening to music in English every day in Ireland?

more than 5 hours	*3 to 5 hours*	*1 to 2 hours*	*less than 1 hour*	*no time*

Your contact with Polish

8. Do you think you use more Polish or English in a normal day?

much more Polish	*more Polish*	*half and half*	*more English*	*much more English*

9. How often do you speak Polish in the following situations in Ireland?

Polish use	*always*	*often*	*sometimes*	*not often*	*never*
with family					
with friends					
in your free time					
at school					

10. How much time do you spend watching TV and listening to music in Polish every day in Ireland?

more than 5 hours	*3 to 5 hours*	*1 to 2 hours*	*less than 1 hour*	*no time*

Your language motivation and attitudes

11. How important is it for you to speak English well?

very important	*important*	*neither important nor unimportant*	*unimportant*	*very unimportant*

12. How easy do you find it to…

	very easy	*easy*	*neither easy nor difficult*	*difficult*	*very difficult*
learn English?					
understand the Irish people?					

13. When you speak English, how important is it for you to sound like the Irish?

very important	*important*	*neither important nor unimportant*	*unimportant*	*very unimportant*

14. (a) Are there situations in which you feel uneasy speaking English?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, can you describe such a situation?

.....

15. (a) Do you like speaking English?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, say why. .....

(c) If your answer is NO, say why. .....

16. Do you try and imitate English sounds (e.g. by singing, repeating phrases you hear)?

☐ *Yes.* ☐ *No.*

17. How much would you like to become similar to the Irish people?

very much	*much*	*neutral*	*not*	*not at all*

18. (a) How happy do you feel living in Ireland?

very happy	*happy*	*neutral*	*unhappy*	*very unhappy*

(b) Can you say what makes you feel this way? *(Please give details)*

.....

.....

19. Can you please complete the following sentences? ☺

a/ Learning English is important for me because.....

.....

b/ What my parents think about English is that.....

.....

c/ Whenever I think of my future, I imagine myself.....

.....

@ General background

20. How old are you?

21. How old were you when you came to Ireland?

22. What is your Mum's job?

23. What is your Dad's job?

24. Do you go to a Polish weekend school in Ireland?

☐ *Yes.* ☐ *No.*

25. (a) Have you learnt any other foreign languages besides English? (*Please consider <u>all</u> the foreign languages you have learnt in your life)*

☐ *Yes.* ☐ *No.*

(b) If your answer is YES, which languages?

☐ *Irish* ☐ *German* ☐ *French* ☐ *Russian* ☐ *other:*

Thank you very much for your time and help!

Background questionnaire

Polish children and adults in Poland

L2 speech perception and production study

Thank you for agreeing to participate in the Polish Diaspora Project funded by the IRCHSS. It investigates the Polish people living in Ireland from a number of perspectives. In this questionnaire we would like to ask you about ***your English language learning and some general information about yourself****. Most of the questions can be answered by ticking (✓) one of the relevant boxes. In those cases where you need to write in an answer, you can use either English or Polish.*

You will need about 3 minutes to complete the questionnaire.

ID code: ☐

Your contact with English

1. (a) Have you ever learned English?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES:

(i) How old were you when you first learnt English? ☐

(ii) What kind of course was it? ☐

2. (a) Are you taking any English classes now?

☐ *Yes.* ☐ *No.*

(b) If your answer is YES:

(i) What kind of course is it? ☐

(ii) How many hours per week? ☐

(iii) Is your teacher a native speaker of English? ☐ *Yes.* ☐ *No.*

@ General background

3. Gender: ☐ *male* ☐ *female*

4. Level of education attained (adults):

☐ *primary* ☐ *vocational* ☐ *secondary* ☐ *tertiary*

5. Other foreign languages besides English: *(Please, indicate <u>all</u> the foreign languages you have ever learned regardless of your present proficiency in them)*

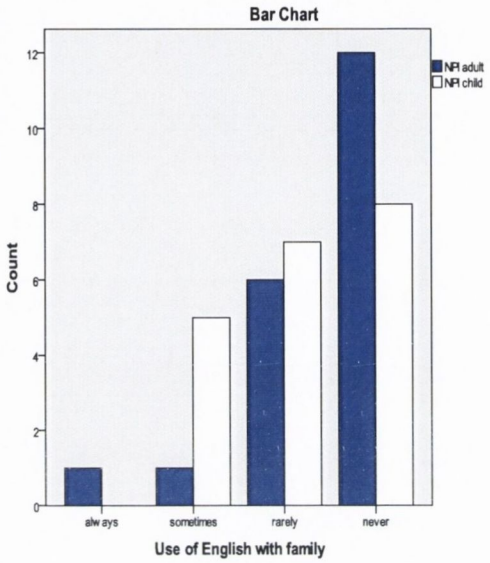
☐ *German* ☐ *French* ☐ *Russian* ☐ *other:*

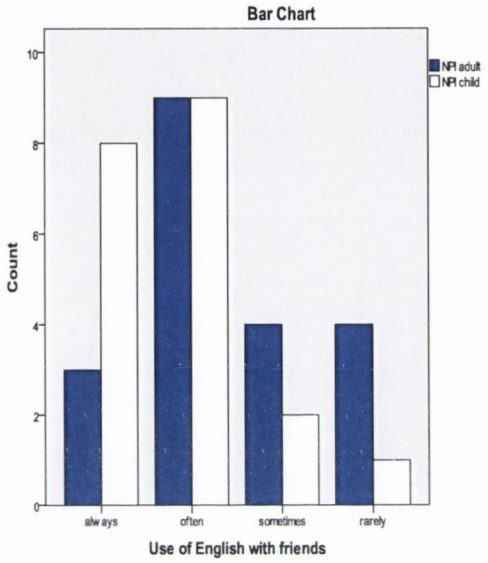
Thank you very much for your time and help!

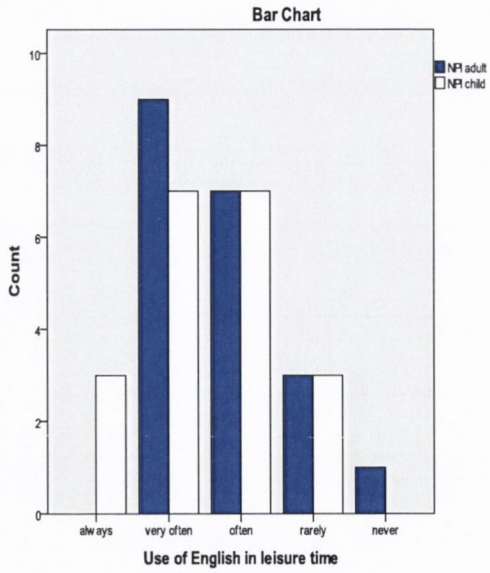
Appendix 7

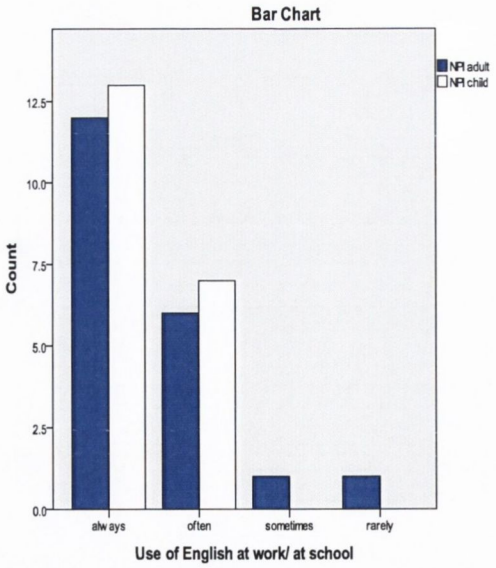
Summary of questionnaire data (NPI participants)

I. Use of English in everyday life in Ireland









N.B. NPI adults (N=20); NPI children (N=20).

Time spent on passive activities in English every day * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Time spent on passive activities in English every day	more than 5 hours a day	3	4	7
	3 to 5 hours a day	5	6	11
	1 to 2 hours a day	8	10	18
	less than 1 hour a day	4	0	4
Total		20	20	40

Current English classes * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Are you taking any extra English classes?	yes	5	3	8
	no	15	17	32
Total		20	20	40

Use of English with native speakers * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Frequency of speaking English with native speakers	very often	9	12	21
	often	7	6	13
	sometimes	4	1	5
Total		20	19	39

Relationship to native speakers * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Relationship to native speakers	informal	0	2	2
	formal	9	0	9
	formal and informal	9	18	27
	family/partner & formal and informal	2	0	2
Total		20	20	40

Use of English with non-native speakers of English * Age groups Crosstabulation

Count

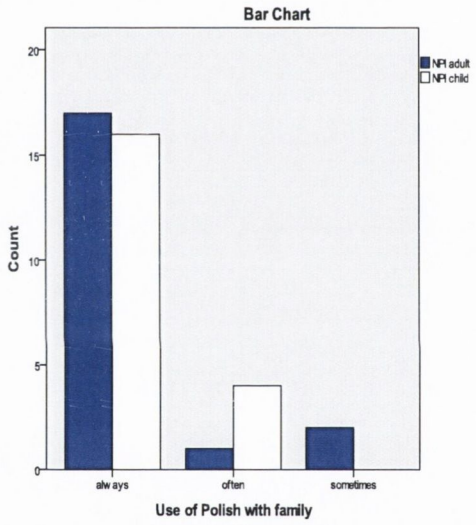
		Groups		
		NPI adult	NPI child	Total
Frequency of speaking English with non-native speakers	very often	5	5	10
	often	9	6	15
	sometimes	5	3	8
	rarely	1	5	6
Total		20	19	39

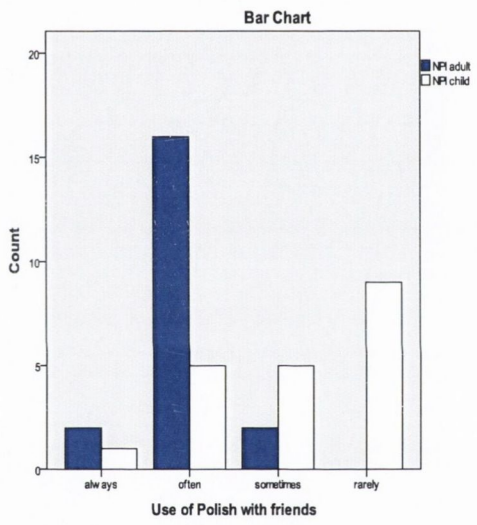
Use of English/Polish in everyday life in Ireland * Age groups Crosstabulation

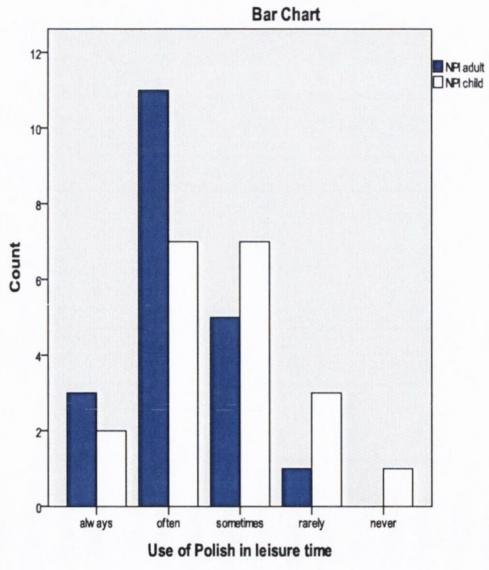
Count

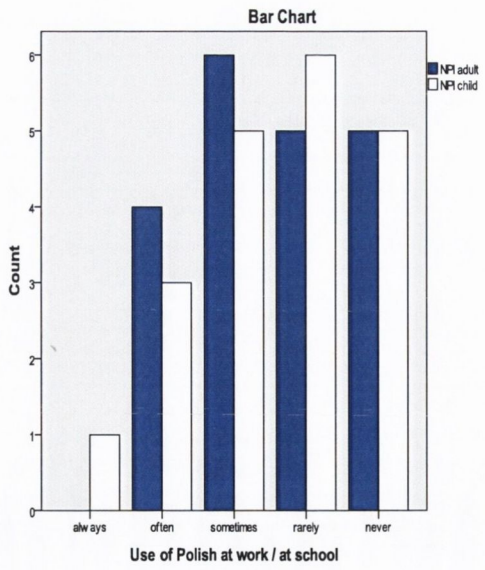
		Groups		
		NPI adult	NPI child	Total
Balance of use of English/Polish in Ireland	much more Polish	1	0	1
	more Polish	4	4	8
	half and half	9	12	21
	more English	2	4	6
	much more English	4	0	4
Total		20	20	40

II. Use of Polish in everyday life in Ireland









N.B. NPI adult (N=20), NPI children (N=20).

Time spent on passive activities in Polish every day * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Time spent on passive activities in Polish every day	more than 5 hours a day	2	2	4
	3 to 5 hours a day	5	7	12
	1 to 2 hours a day	4	7	11
	less than 1 hour a day	4	2	6
	no time	5	2	7
Total		20	20	40

III. Attitudes and motivations

Importance of speaking English fluently * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Importance of speaking English fluently	very important	15	11	26
	important	5	8	13
	neither important nor unimportant	0	1	1
Total		20	20	40

Importance of sounding native-like in English * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Importance of sounding native-like in English	very important	5	4	9
	important	9	4	13
	neither important nor unimportant	4	7	11
	unimportant	1	4	5
	very unimportant	1	1	2
Total		20	20	40

Ease of learning English * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Ease of learning English	very easy	4	7	11
	easy	9	10	19
	neither easy nor difficult	4	3	7
	difficult	3	0	3
Total		20	20	40

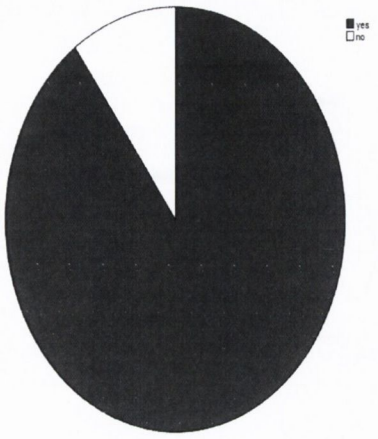
Ease of understanding Irish English * Age groups Crosstabulation

Count

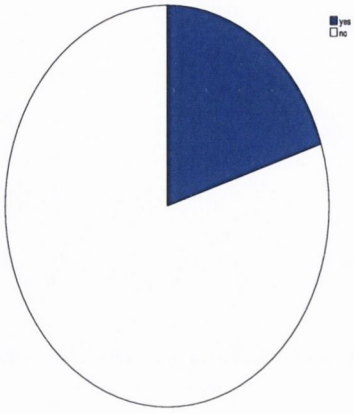
		Groups		
		NPI adult	NPI child	Total
Ease of understanding Irish English	very easy	0	6	6
	easy	7	11	18
	neither easy nor difficult	6	2	8
	difficult	7	1	8
Total		20	20	40

Are there situations in which you feel uneasy speaking English?

NPI adults



NPI children

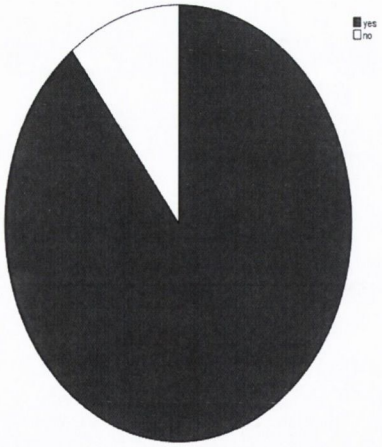


Most commonly mentioned kinds of uneasy situations:

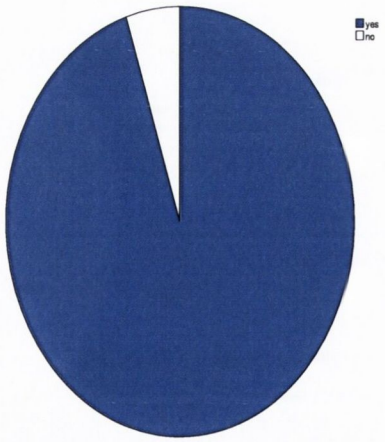
- Formal contexts (at the doctor's, job interviews etc.)
- Power relationships (at work)
- Telephoning
- Communication with English native speakers with strong Irish accent
- After a longish holiday in Poland
- Long presentations at school
- Providing complex explanations to friends and/or teachers

Do you like speaking English?

NPI adults



NPI children



Most common reasons for positive feelings about speaking English:

- Symbol of personal success and abilities
- Access to different people's opinions
- Preference of English to Polish
- Friends speak English
- 'Nice' and 'fun' language

Feedback on English pronunciation (NPI adults only)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	16	80.0	84.2	84.2
	no	3	15.0	15.8	100.0
	Total	19	95.0	100.0	
Missing	System	1	5.0		
Total		20	100.0		

Level of satisfaction with English pronunciation (NPI adults only)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	satisfied	5	25.0	25.0	25.0
	neither satisfied nor dissatisfied	7	35.0	35.0	60.0
	dissatisfied	7	35.0	35.0	95.0
	very dissatisfied	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Attempts at imitating (Irish) English accent * Age groups Crosstabulation

Count

		Groups		Total
		NPI adult	NPI child	
Attempts at imitating (Irish) English accent	yes	11	10	21
	no	9	10	19
Total		20	20	40

Attitudes towards the Irish and contentment about life in Ireland

Descriptives

	Age groups		Statistic
Levels of identification with the Irish people	NPI adult	Mean	3.40
		Std. Deviation	.681
		Minimum	2
		Maximum	5
	NPI child	Mean	3.95
		Std. Deviation	.826
		Minimum	3
		Maximum	5
Levels of happiness in Ireland	NPI adult	Mean	1.80
		Std. Deviation	.768
		Minimum	1
		Maximum	3
	NPI child	Mean	2.20
		Std. Deviation	.951
		Minimum	1
		Maximum	4

(1= very high, 2=high, 3=neither high nor low, 4=rather low, 5=low)

Reasons for feelings of happiness in Ireland:

NPI adults:

- Good job
- Nice and friendly people
- Relaxed non-judgemental atmosphere
- Supportive working environment
- Quality of life
- 'Easy' life
- Ireland as a symbol of their life success
- Possibility to meet new people and cultures
- Contact with Polish friends

NPI children:

- Nice and polite people
- Easier school
- Possibility to learn English well
- New friends
- Lifestyle
- Happy parents
- Feelings of being at home

Main reasons for the importance of learning English:

NPI adults

- Current life and work in Ireland
- Access to good job opportunities
- Hope of keeping a job which requires the use of English
- International communication and travels
- Means of getting to know new cultures

NPI children

- Better job opportunities in the future (both in Ireland, Poland and elsewhere)
- Communication with peers and other people

Ideal L2-self * Age groups Crosstabulation

Count

		Groups		
		NPI adult	NPI child	Total
Ideal L2-self	Having a job in Poland, where use of English is required	3	2	5
	Living in Poland	3	1	4
	Having a job, where use of English is required	4	8	12
	Living in Ireland	2	1	3
	Living in an English-speaking country	2	2	4
	Travelling and communicating with diverse people	1	0	1
	Changeable/ other	4	6	9
Total		19	20	39

Appendix 8

Cross-language phonetic similarity task: group statistics

Descriptive statistics

Overall fit index score

Group	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
NPI adult	20	3.42	1.025	.229	2	5
NPI child	20	3.26	.841	.188	1	5
NPP adult	9	2.41	.949	.316	1	4
NPP child	10	3.20	.535	.169	2	4
Total	59	3.18	.927	.121	1	5

Test of Homogeneity of Variances

Overall fit index score

Levene Statistic	df1	df2	Sig.
1.614	3	55	.197

ANOVA

Overall fit index score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.669	3	2.223	2.831	.047
Within Groups	43.192	55	.785		
Total	49.861	58			

Multiple Comparisons

Overall fit index score: Tukey HSD

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
NPI adult	NPI child	.160	.280	.940	-.58	.90
	NPP adult	1.014*	.356	.030	.07	1.96
	NPP child	.225	.343	.913	-.68	1.13
NPI child	NPI adult	-.160	.280	.940	-.90	.58
	NPP adult	.854	.356	.089	-.09	1.80
	NPP child	.065	.343	.998	-.84	.97
NPP adult	NPI adult	-1.014*	.356	.030	-1.96	-.07
	NPI child	-.854	.356	.089	-1.80	.09
	NPP child	-.789	.407	.225	-1.87	.29
NPP child	NPI adult	-.225	.343	.913	-1.13	.68
	NPI child	-.065	.343	.998	-.97	.84
	NPP adult	.789	.407	.225	-.29	1.87

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Individual fit index scores: Tukey HSD

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Fit index *beat*	NPI adult	NPI child	.400	.599	.909	-1.19	1.99
		NPP adult	1.044	.760	.520	-.97	3.06
		NPP child	-.500	.733	.904	-2.44	1.44
	NPI child	NPI adult	-.400	.599	.909	-1.99	1.19
		NPP adult	.644	.760	.831	-1.37	2.66
		NPP child	-.900	.733	.612	-2.84	1.04
	NPP adult	NPI adult	-1.044	.760	.520	-3.06	.97
		NPI child	-.644	.760	.831	-2.66	1.37
		NPP child	-1.544	.870	.296	-3.85	.76
	NPP child	NPI adult	.500	.733	.904	-1.44	2.44
		NPI child	.900	.733	.612	-1.04	2.84
		NPP adult	1.544	.870	.296	-.76	3.85
Fit index *bat*	NPI adult	NPI child	.600	.493	.619	-.71	1.91
		NPP adult	1.417	.626	.120	-.24	3.08
		NPP child	1.550	.604	.061	-.05	3.15
	NPI child	NPI adult	-.600	.493	.619	-1.91	.71
		NPP adult	.817	.626	.564	-.84	2.48
		NPP child	.950	.604	.403	-.65	2.55
	NPP adult	NPI adult	-1.417	.626	.120	-3.08	.24
		NPI child	-.817	.626	.564	-2.48	.84
		NPP child	.133	.717	.998	-1.77	2.03
	NPP child	NPI adult	-1.550	.604	.061	-3.15	.05
		NPI child	-.950	.604	.403	-2.55	.65
		NPP adult	-.133	.717	.998	-2.03	1.77
Fit index *boot*	NPI adult	NPI child	-.250	.573	.972	-1.77	1.27
		NPP adult	.539	.728	.880	-1.39	2.47
		NPP child	-.550	.702	.862	-2.41	1.31
	NPI child	NPI adult	.250	.573	.972	-1.27	1.77
		NPP adult	.789	.728	.701	-1.14	2.72
		NPP child	-.300	.702	.974	-2.16	1.56
	NPP adult	NPI adult	-.539	.728	.880	-2.47	1.39
		NPI child	-.789	.728	.701	-2.72	1.14
		NPP child	-1.089	.833	.563	-3.30	1.12
	NPP child	NPI adult	.550	.702	.862	-1.31	2.41
		NPI child	.300	.702	.974	-1.56	2.16
		NPP adult	1.089	.833	.563	-1.12	3.30

Multiple Comparisons
Individual fit index scores: Tukey HSD

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Fit index *bought*	NPI adult	NPI child	.350	.463	.874	-.88	1.58
		NPP adult	1.678*	.588	.030	.12	3.23
		NPP child	.100	.567	.998	-1.40	1.60
	NPI child	NPI adult	-.350	.463	.874	-1.58	.88
		NPP adult	1.328	.588	.120	-.23	2.88
		NPP child	-.250	.567	.971	-1.75	1.25
	NPP adult	NPI adult	-1.678*	.588	.030	-3.23	-.12
		NPI child	-1.328	.588	.120	-2.88	.23
		NPP child	-1.578	.673	.100	-3.36	.20
	NPP child	NPI adult	-.100	.567	.998	-1.60	1.40
		NPI child	.250	.567	.971	-1.25	1.75
		NPP adult	1.578	.673	.100	-.20	3.36
Fit index *but* in relation to *buty*	NPI adult	NPI child	-1.450	.660	.137	-3.20	.30
		NPP adult	-1.122	.838	.543	-3.34	1.10
		NPP child	-.100	.809	.999	-2.24	2.04
	NPI child	NPI adult	1.450	.660	.137	-.30	3.20
		NPP adult	.328	.838	.980	-1.89	2.55
		NPP child	1.350	.809	.350	-.79	3.49
	NPP adult	NPI adult	1.122	.838	.543	-1.10	3.34
		NPI child	-.328	.838	.980	-2.55	1.89
		NPP child	1.022	.960	.712	-1.52	3.56
	NPP child	NPI adult	.100	.809	.999	-2.04	2.24
		NPI child	-1.350	.809	.350	-3.49	.79
		NPP adult	-1.022	.960	.712	-3.56	1.52
Fit index *but* in relation to *boty*	NPI adult	NPI child	.900	.686	.560	-.92	2.72
		NPP adult	.628	.871	.889	-1.68	2.94
		NPP child	-.450	.841	.950	-2.68	1.78
	NPI child	NPI adult	-.900	.686	.560	-2.72	.92
		NPP adult	-.272	.871	.989	-2.58	2.04
		NPP child	-1.350	.841	.384	-3.58	.88
	NPP adult	NPI adult	-.628	.871	.889	-2.94	1.68
		NPI child	.272	.871	.989	-2.04	2.58
		NPP child	-1.078	.997	.703	-3.72	1.56
	NPP child	NPI adult	.450	.841	.950	-1.78	2.68
		NPI child	1.350	.841	.384	-.88	3.58
		NPP adult	1.078	.997	.703	-1.56	3.72

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Individual fit index scores: Tukey HSD

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Fit index *bet*	NPI adult	NPI child	.650	.570	.666	-.86	2.16
		NPP adult	2.078*	.724	.029	.16	3.99
		NPP child	.900	.698	.574	-.95	2.75
	NPI child	NPI adult	-.650	.570	.666	-2.16	.86
		NPP adult	1.428	.724	.211	-.49	3.34
		NPP child	.250	.698	.984	-1.60	2.10
	NPP adult	NPI adult	-2.078*	.724	.029	-3.99	-.16
		NPI child	-1.428	.724	.211	-3.34	.49
		NPP child	-1.178	.828	.491	-3.37	1.02
	NPP child	NPI adult	-.900	.698	.574	-2.75	.95
		NPI child	-.250	.698	.984	-2.10	1.60
		NPP adult	1.178	.828	.491	-1.02	3.37
Fit index *boat*	NPI adult	NPI child	.500	.617	.849	-1.14	2.14
		NPP adult	1.683	.784	.151	-.39	3.76
		NPP child	.850	.756	.676	-1.15	2.85
	NPI child	NPI adult	-.500	.617	.849	-2.14	1.14
		NPP adult	1.183	.784	.438	-.89	3.26
		NPP child	.350	.756	.967	-1.65	2.35
	NPP adult	NPI adult	-1.683	.784	.151	-3.76	.39
		NPI child	-1.183	.784	.438	-3.26	.89
		NPP child	-.833	.897	.789	-3.21	1.54
	NPP child	NPI adult	-.850	.756	.676	-2.85	1.15
		NPI child	-.350	.756	.967	-2.35	1.65
		NPP adult	.833	.897	.789	-1.54	3.21
Fit index *bit* in relation to *bity*	NPI adult	NPI child	1.250	.650	.231	-.47	2.97
		NPP adult	1.894	.825	.111	-.29	4.08
		NPP child	.150	.796	.998	-1.96	2.26
	NPI child	NPI adult	-1.250	.650	.231	-2.97	.47
		NPP adult	.644	.825	.863	-1.54	2.83
		NPP child	-1.100	.796	.516	-3.21	1.01
	NPP adult	NPI adult	-1.894	.825	.111	-4.08	.29
		NPI child	-.644	.825	.863	-2.83	1.54
		NPP child	-1.744	.945	.263	-4.25	.76
	NPP child	NPI adult	-.150	.796	.998	-2.26	1.96
		NPI child	1.100	.796	.516	-1.01	3.21
		NPP adult	1.744	.945	.263	-.76	4.25

*. The mean difference is significant at the 0.05 level.

Appendix 9

Categorical discrimination task: group statistics

Overall A' score

Descriptive statistics

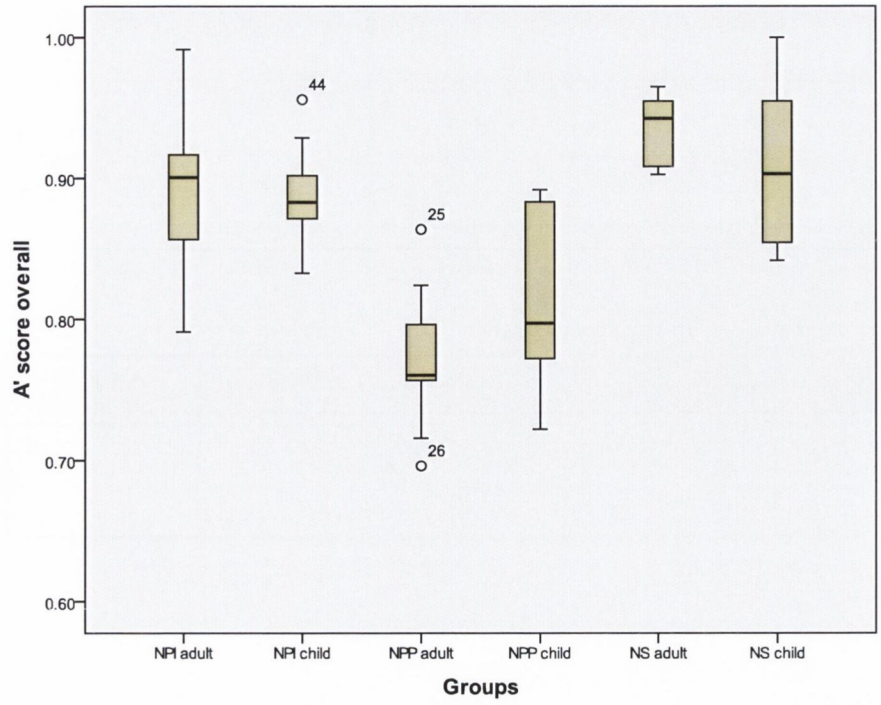
Group	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
NPI adult	20	.8944	.04510	.01008	.79	.99
NPI child	20	.8835	.03048	.00681	.83	.96
NPP adult	9	.7733	.05164	.01721	.70	.86
NPP child	10	.8107	.06441	.02037	.72	.89
NS adult	10	.9356	.02295	.00726	.90	.96
NS child	10	.9106	.05635	.01782	.84	1.00
Total	79	.8745	.06612	.00744	.70	1.00

Test of Homogeneity of Variances

Overall A' score

Levene Statistic	df1	df2	Sig.
3.287	5	73	.010

Exploratory box plots of overall A' scores for individual participant groups



Kruskal-Wallis Test
Individual A' scores

	group	N	Mean Rank
A' score *beat-bit*	NPI adult	20	37.12
	NPI child	20	38.25
	NPP adult	9	27.72
	NPP child	10	17.75
	NS adult	10	62.70
	NS child	10	59.85
A' score *bet-bit*	NPI adult	20	51.58
	NPI child	20	42.20
	NPP adult	9	17.67
	NPP child	10	36.00
	NS adult	10	42.30
	NS child	10	34.25
A' score *bet-bat*	NPI adult	20	44.08
	NPI child	20	40.32
	NPP adult	9	29.33
	NPP child	10	39.05
	NS adult	10	41.75
	NS child	10	40.00
A' score *boot-but*	NPI adult	20	43.50
	NPI child	20	39.70
	NPP adult	9	15.94
	NPP child	10	30.65
	NS adult	10	53.05
	NS child	10	51.55
A' score *boat-bought*	NPI adult	20	44.38
	NPI child	20	43.12
	NPP adult	9	16.00
	NPP child	10	16.70
	NS adult	10	60.90
	NS child	10	49.00
	Total	79	

Test Statistics[a,b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Chi-Square	31.293	15.621	2.896	18.371	31.565
df	5	5	5	5	5
Asymp. Sig.	.000	.008	.716	.003	.000

a. Kruskal Wallis Test

b. Grouping Variable: group

Mann-Whitney *U* Test
Comparisons between NPI adults and NPI children: categorical discrimination of individual L2 pairs

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	189.000	147.500	179.000	180.500	189.500
Wilcoxon W	399.000	357.500	389.000	390.500	399.500
Z	-.313	-1.502	-.608	-.538	-.286
Asymp. Sig. (2-tailed)	.754	.133	.543	.591	.775
Exact Sig. [2*(1-tailed Sig.)]	.779[a]	.157[a]	.583[a]	.602[a]	.779[a]

a. Not corrected for ties.

b. Grouping Variable: NPI adult/ NPI child

Mann-Whitney *U* Test
Comparisons between NPI children and NS children: categorical discrimination of individual L2 pairs

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	36.500	79.500	99.500	67.500	87.000
Wilcoxon W	246.500	134.500	154.500	277.500	297.000
Z	-2.871	-.928	-.023	-1.466	-.575
Asymp. Sig. (2-tailed)	.004	.353	.982	.143	.565
Exact Sig. [2*(1-tailed Sig.)]	.004[a]	.373[a]	.983[a]	.155[a]	.588[a]

a. Not corrected for ties.

b. Grouping Variable: NPI child/ NS child

Mann-Whitney *U* Test
Comparisons between NPI children and NPP children: categorical discrimination of individual L2 pairs

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	35.000	84.500	95.000	76.000	27.000
Wilcoxon W	90.000	139.500	150.000	131.000	82.000
Z	-3.165	-.701	-.230	-1.071	-3.251
Asymp. Sig. (2-tailed)	.002	.483	.818	.284	.001
Exact Sig. [2*(1-tailed Sig.)]	.003[a]	.502[a]	.846[a]	.307[a]	.001[a]

a. Not corrected for ties.

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	35.000	84.500	95.000	76.000	27.000
Wilcoxon W	90.000	139.500	150.000	131.000	82.000
Z	-3.165	-.701	-.230	-1.071	-3.251
Asymp. Sig. (2-tailed)	.002	.483	.818	.284	.001
Exact Sig. [2*(1-tailed Sig.)]	.003[a]	.502[a]	.846[a]	.307[a]	.001[a]

b. Grouping Variable: NPI child/NPP child

Mann-Whitney *U* Test
Comparisons between NPI adults and NS adults: categorical discrimination of individual L2 pairs

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	40.000	73.500	91.500	72.500	52.500
Wilcoxon W	250.000	128.500	146.500	282.500	262.500
Z	-2.674	-1.228	-.395	-1.243	-2.122
Asymp. Sig. (2-tailed)	.007	.220	.693	.214	.034
Exact Sig. [2*(1-tailed Sig.)]	.007[a]	.248[a]	.713[a]	.231[a]	.035[a]

a. Not corrected for ties.

b. Grouping Variable: NPI adult/NS adult

Mann-Whitney *U* Test
Comparisons between NPI adults and NPP adults: categorical discrimination of individual L2 pairs

Test Statistics[b]

	A' score beat-bit	A' score bet-bit	A' score bet-bat	A' score boot-but	A' score boat-bought
Mann-Whitney U	70.000	13.500	60.500	24.500	24.500
Wilcoxon W	115.000	58.500	105.500	69.500	69.500
Z	-.971	-3.730	-1.477	-3.121	-3.129
Asymp. Sig. (2-tailed)	.331	.000	.140	.002	.002
Exact Sig. [2*(1-tailed Sig.)]	.365[a]	.000[a]	.167[a]	.001[a]	.001[a]

a. Not corrected for ties.

b. Grouping Variable: NPI adult/NPP adult

Appendix 10

Delayed-repetition task: group statistics

Descriptive statistics

Overall production score

Group	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
NPI adult	20	.6457	.13709	.03065	.38	.84
NPI child	20	.7101	.13014	.02910	.45	.89
NPP adult	9	.5460	.09759	.03253	.39	.66
NPP child	10	.5716	.08210	.02596	.39	.68
NS adult	10	.8916	.07997	.02529	.77	.98
NS child	10	.8148	.08596	.02718	.64	.95
Total	79	.6938	.15504	.01744	.38	.98

Test of Homogeneity of Variances

Overall production score

Levene Statistic	df1	df2	Sig.
2.022	5	73	.085

ANOVA

Overall production score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.935	5	.187	14.526	.000
Within Groups	.940	73	.013		
Total	1.875	78			

Overall production score: homogeneous subgroups

Tukey HSD

group	N	Subset for alpha = 0.05			
		1	2	3	4
NPP adult	9	.5460			
NPP child	10	.5716			
NPI adult	20	.6457	.6457		
NPI child	20		.7101	.7101	
NS child	10			.8148	.8148
NS adult	10				.8916
Sig.		.284	.743	.235	.574

Means for groups in homogeneous subsets are displayed.

Multiple comparisons

Overall production score: Bonferroni

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
NPI adult	NPI child	-.06431	.03588	1.000	-.1732	.0446
	NPP adult	.09978	.04554	.475	-.0384	.2380
	NPP child	.07412	.04394	1.000	-.0592	.2075
	NS adult	-.24588*	.04394	.000	-.3792	-.1125
	NS child	-.16900*	.04394	.004	-.3024	-.0356
NPI child	NPI adult	.06431	.03588	1.000	-.0446	.1732
	NPP adult	.16409*	.04554	.009	.0259	.3023
	NPP child	.13844*	.04394	.035	.0051	.2718
	NS adult	-.18156*	.04394	.001	-.3149	-.0482
	NS child	-.10469	.04394	.297	-.2381	.0287
NPP adult	NPI adult	-.09978	.04554	.475	-.2380	.0384
	NPI child	-.16409*	.04554	.009	-.3023	-.0259
	NPP child	-.02565	.05213	1.000	-.1839	.1326
	NS adult	-.34565*	.05213	.000	-.5039	-.1874
	NS child	-.26878*	.05213	.000	-.4270	-.1106
NPP child	NPI adult	-.07412	.04394	1.000	-.2075	.0592
	NPI child	-.13844*	.04394	.035	-.2718	-.0051
	NPP adult	.02565	.05213	1.000	-.1326	.1839
	NS adult	-.32000*	.05074	.000	-.4740	-.1660
	NS child	-.24313*	.05074	.000	-.3971	-.0891
NS adult	NPI adult	.24588*	.04394	.000	.1125	.3792
	NPI child	.18156*	.04394	.001	.0482	.3149
	NPP adult	.34565*	.05213	.000	.1874	.5039
	NPP child	.32000*	.05074	.000	.1660	.4740
	NS child	.07687	.05074	1.000	-.0771	.2309
NS child	NPI adult	.16900*	.04394	.004	.0356	.3024
	NPI child	.10469	.04394	.297	-.0287	.2381
	NPP adult	.26878*	.05213	.000	.1106	.4270
	NPP child	.24313*	.05074	.000	.0891	.3971
	NS adult	-.07687	.05074	1.000	-.2309	.0771

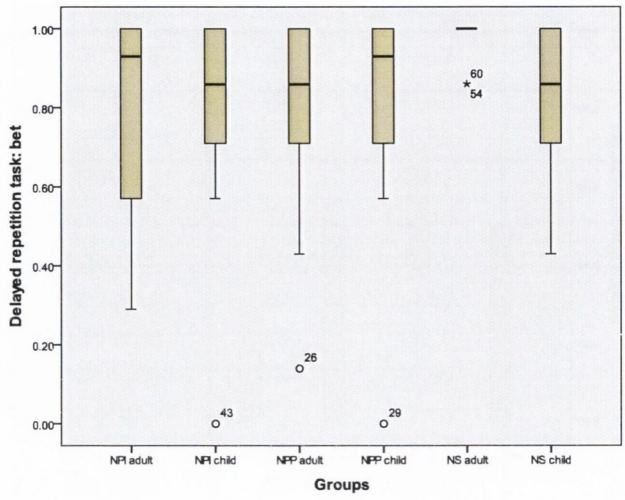
*. The mean difference is significant at the 0.05 level.

Test of Homogeneity of Variances

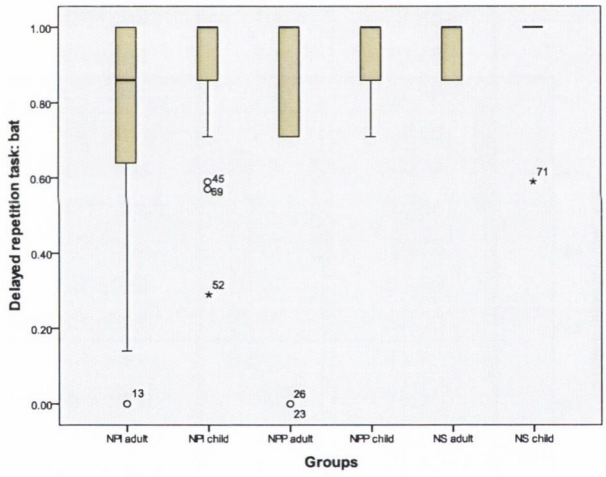
Individual production scores for all groups

	Levene Statistic	df1	df2	Sig.
production: bet	2.658	5	73	.029
production: bat	5.765	5	73	.000
production: boat	5.368	5	73	.000
production: but	3.269	5	73	.010
production: bought	.962	5	73	.447
production: beat	3.366	5	73	.009
production: boot	2.204	5	73	.063
production: bit	1.231	5	73	.303

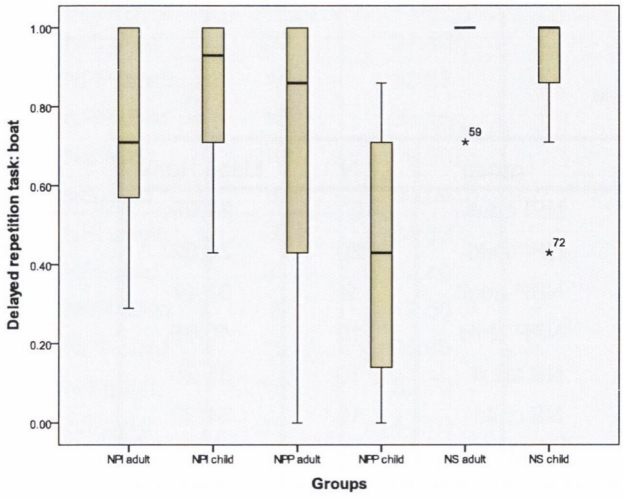
Exploratory box plots of 'bet' productions for individual participant groups



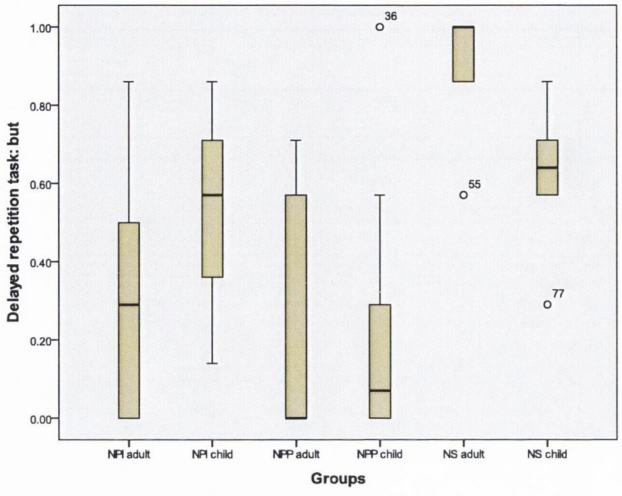
Exploratory box plots of 'bat' productions for individual participant groups



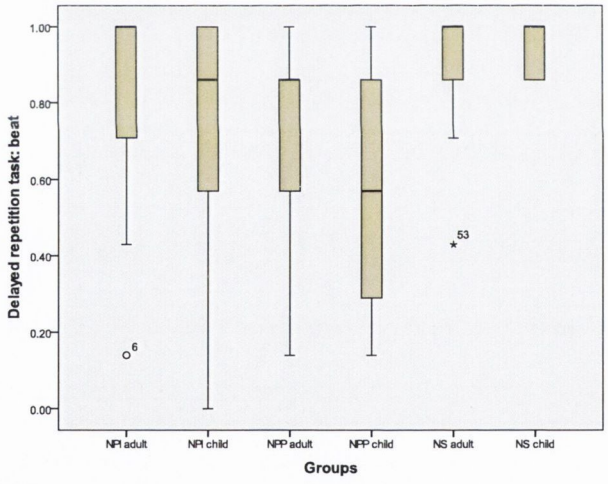
Exploratory box plots of 'boat' productions for individual participant groups



Exploratory box plots of 'but' productions for individual participant groups



Exploratory box plots of 'beat' productions for individual participant groups



Kruskal-Wallis Test
Individual production scores

	group	N	Mean Rank
production: bet	NPI adult	20	39.25
	NPI child	20	36.82
	NPP adult	9	37.44
	NPP child	10	40.05
	NS adult	10	55.20
	NS child	10	34.90
	Total	79	

Kruskal-Wallis Test
Individual production scores

	group	N	Mean Rank
production: bat	NPI adult	20	29.12
	NPI child	20	41.10
	NPP adult	9	36.39
	NPP child	10	43.05
	NS adult	10	47.40
	NS child	10	52.35
production: boat	NPI adult	20	34.30
	NPI child	20	43.70
	NPP adult	9	38.61
	NPP child	10	17.50
	NS adult	10	58.60
	NS child	10	49.15
production: but	NPI adult	20	29.32
	NPI child	20	44.88
	NPP adult	9	24.61
	NPP child	10	23.65
	NS adult	10	70.45
	NS child	10	51.35
production: bought	NPI adult	20	44.48
	NPI child	20	32.72
	NPP adult	9	24.50
	NPP child	10	35.75
	NS adult	10	51.60
	NS child	10	52.20
production: beat	NPI adult	20	43.80
	NPI child	20	36.30
	NPP adult	9	30.33
	NPP child	10	26.10
	NS adult	10	48.00
	NS child	10	54.40
production: boot	NPI adult	20	31.58
	NPI child	20	37.42
	NPP adult	9	32.83
	NPP child	10	35.15
	NS adult	10	60.30
	NS child	10	53.00
production: bit	NPI adult	20	34.32
	NPI child	20	53.40
	NPP adult	9	19.50
	NPP child	10	25.60
	NS adult	10	52.70
	NS child	10	44.70
	Total	79	

Test Statistics[a,b]

	production *bat*	production *boat*	production *but*	production *bought*	production *beat*	production *boot*	production *bit*
Chi-Square	11.074	21.605	35.169	12.940	12.721	16.442	23.372
df	5	5	5	5	5	5	5
Asymp. Sig.	.050	.001	.000	.024	.026	.006	.000

a. Kruskal Wallis Test

b. Grouping Variable: group Age groups

Mann-Whitney *U* Test
Comparisons between NPI adults and NPI children: production of individual L2 vowels

Test Statistics[b]

	bet	bat	boat	but	bought	beat	boot	bit
Mann-Whitney U	190.000	138.500	149.000	105.000	135.000	164.000	168.500	97.000
Wilcoxon W	400.000	348.500	359.000	315.000	345.000	374.000	378.500	307.000
Z	-.285	-1.771	-1.437	-2.599	-1.786	-1.027	-.874	-2.833
Asymp. Sig. (2-tailed)	.776	.076	.151	.009	.074	.304	.382	.005
Exact Sig. [2*(1-tailed Sig.)]	.799[a]	.096[a]	.174[a]	.009[a]	.081[a]	.341[a]	.398[a]	.005[a]

a. Not corrected for ties.

b. Grouping Variable: NPI child/NPI adult

Mann-Whitney *U* Test
Comparisons between NPI children and NS children: production of individual L2 vowels

Test Statistics[b]

	bet	bat	boat	but	bought	beat	boot	bit
Mann-Whitney U	94.000	71.500	85.000	75.000	55.500	54.500	61.000	75.500
Wilcoxon W	149.000	281.500	295.000	285.000	265.500	264.500	271.000	130.500
Z	-.277	-1.549	-.720	-1.133	-1.994	-2.144	-1.804	-1.118
Asymp. Sig. (2-tailed)	.782	.121	.472	.257	.046	.032	.071	.264
Exact Sig. [2*(1-tailed Sig.)]	.812[a]	.214[a]	.530[a]	.286[a]	.049[a]	.044[a]	.091[a]	.286[a]

a. Not corrected for ties.

b. Grouping Variable: NPI child/NS child

Mann-Whitney *U* Test
Comparisons between NPI children and NPP children: production of individual L2 vowels

Test Statistics[b]

	bet	bat	boat	but	bought	beat	boot	bit
Mann-Whitney U	92.500	94.500	32.000	36.500	89.500	75.500	93.000	33.000
Wilcoxon W	302.500	304.500	87.000	91.500	299.500	130.500	148.000	88.000
Z	-.347	-.275	-3.068	-2.834	-.470	-1.104	-.317	-3.010
Asymp. Sig. (2-tailed)	.729	.783	.002	.005	.639	.269	.751	.003
Exact Sig. [2*(1-tailed Sig.)]	.746[a]	.812[a]	.002[a]	.004[a]	.650[a]	.286[a]	.779[a]	.002[a]

a. Not corrected for ties.

b. Grouping Variable: NPI child/NPP child

Mann-Whitney *U* Test
Comparisons between NPI adults and NS adults: production of individual L2 vowels

Test Statistics[b]

	bet	bat	boat	but	bought	beat	boot	bit
Mann-Whitney U	64.000	51.000	37.500	6.000	77.000	90.000	29.000	46.500
Wilcoxon W	274.000	261.000	247.500	216.000	287.000	300.000	239.000	256.500
Z	-1.798	-2.311	-2.955	-4.182	-1.027	-.488	-3.256	-2.396
Asymp. Sig. (2-tailed)	.072	.021	.003	.000	.304	.626	.001	.017
Exact Sig. [2*(1-tailed Sig.)]	.120[a]	.031[a]	.005[a]	.000[a]	.328[a]	.681[a]	.001[a]	.017[a]

a. Not corrected for ties.

b. Grouping Variable: NPI adult/ NS adult

Mann-Whitney *U* Test
Comparisons between NPI adults and NPP adults: production of individual L2 vowels

Test Statistics[b]

	bet	bat	boat	but	bought	beat	boot	bit
Mann-Whitney U	85.500	78.500	82.000	73.000	40.000	59.500	86.500	45.000
Wilcoxon W	130.500	288.500	292.000	118.000	85.000	104.500	296.500	90.000
Z	-.226	-.567	-.387	-.829	-2.405	-1.504	-.168	-2.150
Asymp. Sig. (2-tailed)	.821	.571	.699	.407	.016	.132	.867	.032
Exact Sig. [2*(1-tailed Sig.)]	.835[a]	.594[a]	.729[a]	.444[a]	.018[a]	.153[a]	.871[a]	.034[a]

a. Not corrected for ties.
b. Grouping Variable: NPI adult/ NPP adult