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Τμήμα Αγγλικών Σπουδών

Αναγνώριση κλειστών συμφώνων στην Αγγλική ως Δεύτερη Γλώσσα: η περίπτωση των ομιλητών της Κυπριακής διαλέκτου ως Πρώτη Γλώσσα

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Abstract

This dissertation investigates the difficulties adult second language (L2) users of English encounter with plosive consonants in the L2. It presents the results of two tasks examining the acquisition of plosive voicing contrasts by college students with Cypriot Greek (CG) backgrounds. The plosive voicing contrasts examined involve the bilabial plosives [p], [b] (as in English *pacing* vs. *basing*), the alveolar plosives [t], [d] (as in *towering* vs. *dowering*) and the velar plosives [k], [g] (as in *crammer* vs. *grammar*). The tasks focus on the different factors affecting plosive identification and the types of errors involving plosives. With respect to the first issue, the phonetic perception of plosives turns out to be better in voiceless consonants compared to their voiced counterparts, thus providing evidence for the importance of the voicing contrast factor. Factors such as word position, syllable position, and place of articulation seem to also affect plosive identification but they were found to be of secondary importance. With respect to the second issue, the results point to the same direction since it appears that L2 users performed significantly better in voiceless plosives. It is also indicated that they were able to perceive voiced plosives but they treated such instances as a /nasal+voiced plosive/ sequence (prenasalised plosives). Therefore, the overall results support the findings of previous studies suggesting that voiced plosives are realised differently in CG while the difficulties of the L2 CG users with plosives seem to be attributed to VOT differences between the L1 and the L2. The ability of CG users to differentiate between voiceless and voiced plosives in L2 English is affected by the language-specific VOT settings of the L1 resulting in having the same category for voiceless and voiced plosives while /nasal+voiced plosive/ clusters are treated as prenasalised plosives just like in their L1. These obtained results are discussed in relation to the approaches of second language phonology and speech perception and seem to agree mostly with the speech perception approach suggesting that the CG users' difficulties with L2 plosives in English are due to VOT differences (reflecting the language-specific VOT settings of the CG).

Πρόλογος

Στην παρούσα διατριβή εξετάζονται οι δυσκολίες που αντιμετωπίζουν οι ενήλικες ομιλητές της Κυπριακής διαλέκτου με τα κλειστά σύμφωνα στην Αγγλική ως Δεύτερη Γλώσσα. Συγκεκριμένα, παρουσιάζει τα αποτελέσματα δυο μέσων συλλογής δεδομένων που εξετάζουν την απόκτηση των διαφορών μεταξύ άηχων και ηχηρών κλειστών από φοιτητές κολλεγίου, ομιλητών της Κυπριακής διαλέκτου. Οι διαφορές μεταξύ άηχων και ηχηρών κλειστών που εξετάζονται περιλαμβάνουν τα διχειλικά κλειστά [p], [b] (όπως στις Αγγλικές λέξεις *pacing* αντί *basing*), τα οδοντικά κλειστά [t], [d] (όπως στις Αγγλικές λέξεις *towering* αντί *dowering*) και τα υπερωικά κλειστά [k], [g] (όπως στις Αγγλικές λέξεις *crammer* αντί *grammar*). Τα μέσα συλλογής δεδομένων εστιάζουν στους διαφορετικούς παράγοντες που επηρεάζουν την αντίληψη των κλειστών και τους τύπους λαθών που περιλαμβάνουν κλειστά σύμφωνα. Σε σχέση με το πρώτο ζήτημα, η φωνητική αντίληψη των κλειστών φαίνεται να είναι καλύτερη στα άηχα σύμφωνα σε σύγκριση με τα ηχηρά αντίστοιχα τους, παρέχοντας με αυτό τον τρόπο αποδεικτικά στοιχεία για την σημασία του παράγοντα που αφορά τις διαφορές μεταξύ άηχων και ηχηρών. Παράγοντες όπως η θέση της λέξης (word position), η θέση της συλλαβής (syllable position), και ο τόπος της άρθρωσης (place of articulation) φαίνονται επίσης να επηρεάζουν την αντίληψη για τα κλειστά αλλά αποδεικνύονται να είναι δευτερεύουσας σημασίας. Σε σχέση με το δεύτερο ζήτημα, τα αποτελέσματα κατέδειξαν προς την ίδια κατεύθυνση αφού φαίνεται ότι οι χρήστες της Δεύτερης Γλώσσας απέδωσαν αρκετά καλύτερα στα άηχα κλειστά. Φάνηκε επίσης ότι ήταν σε θέση ν’ αντιληφθούν τα ηχηρά κλειστά αλλά ότι αντιμετώπιζαν τέτοια περιστατικά σαν ακολουθία /έρρινου+ηχηρού κλειστού/ (έρρινα κλειστά). Επομένως, τα γενικά αποτελέσματα υποστηρίζουν τα ευρήματα προηγούμενων μελετών που πρότειναν ότι τα ηχηρά κλειστά γίνονται αντιληπτά διαφορετικά στη Κυπριακή διάλεκτο ενώ οι δυσκολίες των ομιλητών (της Κυπριακής διαλέκτου) στην Δεύτερη Γλώσσα με τα κλειστά φαίνεται να οφείλονται σε διαφορες VOT (Voice Onset Time) μεταξύ της Πρώτης και Δεύτερης Γλώσσας. Η ικανότητα των ομιλητών της Κυπριακής διαλέκτου να διακρίνουν τα άηχα και τα ηχηρά κλειστά της Αγγλικής ως Δεύτερη Γλώσσα επηρεάζεται από τα οριζόμενα χαρακτηριστικά VOT της συγκεκριμένης Πρώτης Γλώσσας με αποτέλεσμα να έχουν την ίδια κατηγορία για άηχα και ηχηρά κλειστά ενώ συμπλέγματα συμφώνων που αποτελούνται από /έρρινο+ηχηρό κλειστό/ ν’ αντιμετωπίζονται ως έρρινα κλειστά όπως συμβαίνει στην Πρώτη Γλώσσα. Η συζήτηση των αποτελεσμάτων της μελέτης σε σχέση με τις προσεγγίσεις της φωνολογίας της δεύτερης γλώσσας (second language phonology) και της αντίληψης της ομιλίας (speech perception) φαίνεται να συμφωνεί περισσότερο με την αντίληψη της ομιλίας προτείνοντας ότι οι δυσκολίες των ομιλητών της Κυπριακής διαλέκτου με τα κλειστά σύμφωνα στην Αγγλική ως Δεύτερη Γλώσσα οφείλονται σε διαφορές VOT (εκφράζοντας τα οριζόμενα χαρακτηριστικά VOT της συγκεκριμένης γλώσσας).

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Contents

CHAPTER PAGE

Abstract v

Πρόλογος vi

Acknowledgements viii

Contents x

List of Figures xvii

List of Tables xix

CHAPTER ONE –Introduction 1

Introduction

..........1

1. Factors affecting the identification of plosives 2
2. Types of errors, Second language phonology and speech perception 3
   2.1. Types of errors 3
   2.2. Second language phonology and speech perception 4
3. Purpose of the study 6
4. Research Questions 7
5. Significance of the study 7
6. Definitions of Key Terms 9
7. Assumptions, Delimitations and Limitations 9
8. Organisation of the study 11

Summary 12

CHAPTER TWO – Review of the Literature 13

Introduction 13

1. Second Language Phonology 14
   1.1. Investigating Second Language phonology 14
   1.2. The Acquisition of Phonology 15
   1.3. Linguistic Constraints 18
      1.3.1. Linguistic Universals 18
      1.3.2. Developmental Processes 24

1.3.3. L1 Transfer ……………………………………………..……………………26
1.3.4. Markedness ……………………………………………………………………29
1.3.5. Sensitivity to Phonological and Morphological Environments …………………..32
1.3.6. Critical Period Hypothesis ……………………………………………………..33
1.4. The Ontogeny Model ……………………………………………………………36
1.4.1. Studies on the Ontogeny Model ……………………..…………………………41
1.4.2. The Ontogeny Phylogeny Model ………………………………………………43
1.5. Causes of IL fossilisation ……………………………………..…………………45
2. Speech Perception ……………………………………………..…………………47
2.1. Investigating Speech Perception ……………………………...…………………47
2.2. Observations Shaping Theoretical Thinking ……………………………………50
2.2.1. Categorical Perception ……………………………………………………………50
2.2.2. Phonetic Context ………………………………………………..………………51
2.2.3. Visual Context ……………………………………………………………………52
2.2.4. Lexical and Sentential Context ……………………………..…………………52
2.3. Theories of Speech Perception: Phonemic Categorisation ………………………......53
2.3.1. Motor Theory ……………………………………………………..……………53
2.3.2. Direct Realist Theory ………………………………………………..……………54
2.3.3. General Approach ……………………………………………………...…………55
2.4. Theories of Speech Perception: Phonemic Categorisation and Lexical Knowledge …56
2.4.1. Top-down Theories …………………………………………………………….…56
2.4.2. Bottom-up Theories ………………………………………………………………56
2.5. L2 Speech Perception ……………………………………………………………57
3. The Cypriot Greek (CG) variety …………………………………………………......59
3.1. Cypriot Greek (CG) ……………………………………………………………..59
3.2. The phonological systems of CG and English in comparison ………………………..63
4. Plosive Consonants ...………………………………………………………………...68
4.1. The plosive system of CG and English ………………..…………………………..68
4.1.1. Voicing contrast 70
4.1.2. Place of articulation ……………………………………………………………..71
4.1.3. Adjacent phoneme …………………………………………………………………73
4.1.4. Lexical context ……………………………………………………..………74

4.1.5. Sentential context ……………………………………………………………..…75
Summary: second language phonology and speech perception approaches ………..……………………………...76

CHAPTER THREE – Research Methodology 79
Introduction ……………………………………………………………………………...79
1. Research questions and hypotheses ………………………..………………………79
2. Research design ………………...……………………………………………………82
2.1. Identification tasks ...……………………………………………………………85
3. Materials ………………………………………………………………………………86
3.1. Stimuli ………..……………………………………………………………………86
3.1.1. Word identification task ……………………………………..…………………87
3.1.2. Words-in-sentences identification task ……………………………………….88
3.1.3. Questionnaire …………………………………………………...…………………89
4. Participants ……………………………………………………………………………89
5. Procedure ……………………..………………………………………………………92
6. Data analysis strategy ………………………………………………..………………94
6.1. Coding of responses ……………………………………………..…………………95
6.2. Cleaning and screening data ……………………………………………………95
6.3. Selecting a data analysis strategy ……………………………………..……………95
6.4. Reliability and validity ……………………………………………..……………97
7. Ethical considerations ……………………………………………..……………97
Summary ……………………………………………………………………...…………98

CHAPTER FOUR – Results 99
Introduction ……………………………………………………………………….......99
1. Demographics and Students' Background Data ……………………………………....99
1.1. Participant Exclusion Criteria and English proficiency level …………...……..……100
1.1.1. 2009 and 2010 participants ……………………………………….…………..……101
1.1.2. 2011 participants ……………………………………………………….………..…103

2. Quantitative Results for Research Question 1 ……………………………..…………106
2.1. Word Identification Task ……………………………………………………………107
Summary for the Word Identification task …………………………………………………112
2.1.1. Rank Order of the factors affecting plosive consonants realisation ….…………112
2.2.Words-in-Sentences Identification Task ……………………………………….………114
Summary for the Words-in-Sentences Identification task ………………………………..135
Summary for the word Identification and Words-in-Sentences tasks ...……………………135
3. Quantitative Results for Research Question 2 ……………………………….……….136
3.1. Quantitative Findings: Types of Errors in the Words-in-Sentences Identification Task ………………………………………………………………………………………..136
Summary ……………………………………………………………………………………139

CHAPTER FIVE – Discussion ……………………………...140
Introduction ……..…………………………………………………………………………......140
1. Performance on the Identification Tasks 1 and 2 (Factors Realisation) ……………140
1.1. Interpretation of the Results ………………………………………………..….……140
1.2. Relation to Previous Research Findings ……………………………………………145
1.3. Theoretical Implications ……………………………………………………….……146
2. Performance on the Words-in-Sentences Identification Task (Types of Errors) ……149
2.1. Interpretation of the Results …………………………………………………………149
2.2. Relation to Previous Research Findings ……………………………………………151
2.3. Theoretical Implications ……………………………………………………………152
3. CG users' difficulties with L2 plosives: the result of IL theory or speech perception theory ………………………………………………………………………….…154
Summary ……………………………………………………………………………………161

CHAPTER SIX – Conclusion ……………………………...…………………….....……162
Introduction ……………………………………………………………………….......162
1. Overall Conclusion 162
2. Pedagogical Implications 164
3. Future Directions 165

Summary ……………………………………………………………………………….167

REFERENCES..168

APPENDICES……………………………………………………………………….206

Appendix A – CG difficulties with L2 plosives ……………………………………….206

Appendix B - Word identification task (Version 1) ……….………..……………………207

Appendix C - Word identification task (Version 2) ………………………………………209

Appendix D - Words-in-sentences identification task ……………………………………211

Appendix E - Background Questionnaire …………………………..…………………213

Appendix F – SPSS Output of Quantitative Analysis ……………………………………..215

Word identification task ……………………………………………………………………215

First MANOVA (voicing X place of articulation) ………………………………………….215

Descriptive Statistics ……………………………………………………………………215

Tests of Within-Subjects Effects ……………………………………………………..216

Estimated Marginal Means ……………………………...…………………….…….217

Voicing ……………………………...……………………………………..217

Place of articulation X voicing ……………………………………………………217

Second MANOVA (voicing X place of articulation X word position) .....………………218

Descriptive Statistics ……………………………………………………………………218

Tests of Within-Subjects Effects …...…………………………………………………220

Estimated Marginal Means ………………………………………………….….. …222

Word position ……………………………………………………………………..222

Voicing ……………………………………………………………………………222

Word position X voicing …………………………………………………………223

Tests of within-subjects contrasts ………………………………………………224

Third MANOVA (voicing X place of articulation X syllable position) ....…………..…..229

Descriptive Statistics ……………………………………………………………………229

Tests of Within-Subjects Effects ……………………………………………………...230

Estimated Marginal Means ……………………………………………………………233

Voicing ……………...……………………………………………………..233

Place of articulation ………………………………..…………………….......233

Syllable position ………………………………………………………………..233

Syllable position X voicing ………………………………………………….234
Place of articulation X voicing ………………………………………………234
Words-in-sentences identification task ………………………………………………….235
First MANOVA (voicing X place of articulation) ......…………………………..………235
Descriptive Statistics ………………………………………..………......……235
Tests of Within-Subjects Effects ……………………………………….…………..236
Estimated Marginal Means ……………………………………….…..……..237
Voicing ………………………………………………………………..…………..237
Place of articulation ……………………………………………………………….237
Second MANOVA (voicing X place of articulation X word position) …..………………..238
Word-medial vs. word-final category ……………………………………………….238
Descriptive Statistics ……………………………………………………………….238
Tests of Within-Subjects Effects ……...…………………………………………....239
Estimated Marginal Means ……………………………………………………….241
Word position ………………………..…………………………………………241
Voicing ……………………………………………..………………………..242
Place of articulation ………………………………………………………………242
Word position X voicing ………………………………………………………….242
Place of articulation X voicing ……………………………………………………243
Word position X place of articulation X voicing ………………………………243
Tests of within-subjects contracts 1 ……………………………………….......244
Tests of within-subjects contrasts 2 …………………………………………...246
Bilabial vs. velar plosives …………………………………………………..……248
Descriptive Statistics ………………………………………………………….248
Tests of Within-Subjects Effects …..……………………………………..……..251
Estimated Marginal Means ………………………………………………………250
Voicing ……………………………………………………………….…......251
Word position …………………………………………………………………..252
Word position X place of articulation ………………………………………252
Tests of within-subjects contrasts 1 ……………………………………………...253
Tests of within-subjects contrasts 2 ……………………………………………...255
Third MANOVA (voicing X place of articulation X syllable position) ………………...…257

Descriptive Statistics ……………………………………………………………….257
Tests of Within-Subjects Effects ………………….……………………………..258
Estimated Marginal Means ……………………………………………………260
Syllable position ……………………………………………………………..260
Voicing ……………………………………………………………………261
Place of articulation ……………………………………………………….261
Syllable position X place of articulation …………………………………….261
Syllable position X voicing ………………………………………………….262
Place of articulation X voicing ……………………………………………….262
Syllable position X place of articulation X voicing ………………………......263
Utterance position ……………………………………………………………………..264
Frequency table …………………………………….…………………………264
Types of Errors (MANOVA) .....……………………………………………….…….265
Descriptive Statistics …………………………….……………...…………..265
Tests of Between-Subjects Effects ………………...……………………………267
Appendix G – Descriptive Statistics for performance of participants in terms of the four investigated factors in descending order SPSS Output of Quantitative Analysis ………………………………………………………………………………………..275

List of Figures

FIGURE PAGE

Figure 1: Voice Contrast Hierarchy ……………………………………………………….31

Figure 2: Relationship of transfer and developmental processes to time ……………………37

Figure 3: Relationship of transfer and developmental processes to style ……………………39

Figure 4: Degree of accent …………………………………………………………..…….40

Figure 5: The Ontogeny Phylogeny Model (Major 2001) ………………………………...45

Figure 6: The pyramid diagram of regional and social variation in England (based on Trudgill 1983: 188) ……………………………………………………………………………………60

Figure 7: Sociolinguistic situation in Cyprus (adapted from Sivas 2003a) ………….……61

Figure 8: Midsagittal vocal tract showing the major places of articulation (adapted from Clark et al. 2006) ………………………………………………………………………………72

Figure 9: The deductive approach typically used in quantitative research (adapted from Creswell 2003: 125) ……………………………………………………………………..83

Figure 10: Visual model for quantitative procedures ………………………………..…….84

Figure 11: A grouped frequency distribution for total ENG 101 marks …………………....101

Figure 12: A grouped frequency distribution for the percentages of the 2008 listening midterm …………………………………………………………………….……………..102

Figure 13: A grouped frequency distribution for the percentages of the 2009 listening midterm ……………………………………………………………….………………..…103

Figure 14: A grouped frequency distribution of YPL ……………………………………106

Figure 15: Interaction between voicing X place of articulation …………………………...108

Figure 16: Interaction between voicing X word position ………………………………..110

Figure 17: Interaction between voicing X syllable position ………………………………111

Figure 18: Interaction between voicing X place of articulation ……………………........116

Figure 19: Interaction between word position X place of articulation ……………………..119

Figure 20: Interaction between word position X voicing ………………………………..120

Figure 21: Interaction between place of articulation X voicing ……………………………121

Figure 22: Interaction between word position X place of articulation X voicing (word-medial position) ………………………………………………………………………………..122

Figure 23: Interaction between word position X place of articulation X voicing (word-final position) ………………………………………………………………………………..123

Figure 24: Interaction between word position X place of articulation X voicing (voiced plosives) ……………………………………………………………………………………..124
Figure 25: Interaction between word position X place of articulation X voicing (voiceless plosives) ……………………………………………………………………………………..125
Figure 26: Interaction between word position X place of articulation ……………………..127
Figure 27: Interaction between word position X voicing …………………….……………128
Figure 28: Interaction between syllable position X place of articulation …………………..131
Figure 29: Interaction between syllable position X voicing …………………..……………132
Figure 30: Interaction between syllable position X place of articulation X voicing (voiceless plosives) ……………………………………………………………………………………..133
Figure 31: Interaction between syllable position X place of articulation X voicing (voiced plosives) …………………………………………………………………………………..……134

List of Tables

TABLE PAGE

Table 1: CG and English plosives ……………………………………..……………………2

Table 2: Logical types of universal statement (following Greenberg) ………………………19

Table 3: Continuum indicating the relative roles of the two kinds of processes …………….25

Table 4: Phonological system of consonants in CG (based on Arvaniti 2010: 4) ……….....64

Table 5: Phonological system of consonants in English (based on Carr 1999: xviii) ……….66

Table 6: Minimal pairs test items ……………………………………………………………….87

Table 7: CG speaker Background, Ecological Factors ……………………………………..104

Table 8: Descriptive Statistics for performance of participants in terms of word position, voicing, and place of articulation ………………………………………………………………109

Table 9: Descriptive Statistics for performance of participants in terms of the four investigated factors in descending order …………………………………………………….113

Table 10: Summary of important factors as revealed through participants' performance ….114

Table 11: Descriptive statistics for performance of participants in terms of word position, voicing, and place of articulation ………………………………………………………………117

Table 12: Descriptive results for performance of participants in terms of word position, voicing, and place of articulation (bilabial and velar plosives) …………….......................126

Table 13: Descriptive statistics for performance of participants in terms of syllable position, place of articulation, and voicing ………………………………………………………………129

Table 14: Descriptive results for performance of participants in terms of utterance position, voicing, and place of articulation ………………………………………………………………135

Table 15: Descriptive statistics for performance of participants in terms of correct and incorrect answers ……………………………………………………………………………137

Table 16: Acoustic cues for voicing distinction for English plosives ………………………158

Table 17: Speech perception difficulties…………………………………………………..160

CHAPTER ONE: INTRODUCTION

Introduction

Second language (L2) users often experience a great degree of difficulty identifying non-native phonological segments that do not occur or are realised differently in their first language (L1). These difficulties are believed to be related to a number of factors, such as the Universal Grammar (UG) and to linguistic constraints. Looking at plosive consonant identification by Cypriot Greek (*henceforth* CG) users of L2 English, this study aims at identifying the several factors that influence the identification of plosives, at describing the types of errors with reference to plosives, and at providing a convincing justification for the difficulties faced by the L2 users in terms of plosive voicing distinctions. Specifically, in the effort to account for these difficulties, the approaches of second language phonology and speech perception seem to be particularly promising without implying that the two approaches are contrastive but it may be the case that these complete each other. The second language phonology approach suggests that these difficulties may be due to phonological deficits while the speech perception approach suggests that these may be due to phonetic effects since L2 users are not skilled at attending to the acoustic cue or set of cues that can reliably lead to the discrimination of the members of an L2 contrast.

The rationale for selecting these sounds stems from the fact that they constitute a problem for CG users of L2 English. This is because of the different phonetic and phonological plosive consonant systems of the two linguistic codes in terms of the number of plosives and their acoustic identifications. In general, English is a 6-plosive consonant system consisting of /p b t d k g/[1] whereas for CG the descriptions of plosives vary considerably. According to Arvaniti (2010), CG is an 8-plosive consonant system consisting of /p p^h: t t^h: c c^h: k k^h:/ (unaspirated and aspirated voiceless plosives) involving no voiced plosives, that is /b d g/. This explains why words like ‘sign’ that in Standard Modern Greek (*henceforth* SMG) are pronounced as [ta′bella], in CG are pronounced as [ta′pella]. The same is observed with English words such as ‘league’ [li:g] that is pronounced as [li:k] by CG users of L2 English (see also Appendix A p. 206). A comparison between the plosive consonants of the CG and

[1] Phonemic and phonetic transcriptions are distinguished with // and [] respectively unless otherwise indicated while all English examples and reference to English phonetic properties refer to the Received Pronunciation (RP) dialect spoken in England.

English indicates the differences between the two linguistic codes based on place and manner of articulation (Table 1).

Plosive		Bilabial	Alveolar	Palatal	Velar
	CG	p p^{h}:	t t^{h}:	c c^{h}:	k k^{h}:
	English	p b	t d		k g

Table 1: CG and English plosives[2]

Nonetheless, further descriptions maintain that voiced plosives do exist in CG (Okalidou et al. 2010, Botinis et al. 2004). Based on these accounts, the plosive consonants of CG can be divided into three voicing categories, namely, voiced, aspirated plosives, voiceless, unaspirated plosives (singletons), and voiceless, aspirated plosives (geminates). With reference to the first category (voiced aspirated plosives), this involves 'prenasalised' plosives whose underlying form consists of a /nasal+plosive/ cluster as in [kuˈ^{m}bi] (button). The second and third categories are distinguished based on consonant length (singletons vs. geminates) as indicated in the minimal pair [kuˈpi] (oar) and [kuˈp^{h}:i] (small bowl). As a result, plosive consonants in CG seem to differ considerably when compared to their English counterparts both in place of articulation and voicing. These differences may be the reason for the difficulties of L2 users when attempting to acquire the phonological system of English and specifically the L2 plosive system.

1. Factors affecting the identification of plosives

Successful everyday communication entails that L2 users are confronted with long stretches of sound during continuous speech rather than isolated phonetic segments. This implies that the identification of plosive consonants (acoustic properties of plosives) may be affected by the phonetic environment. The latter involves various factors, such as the voicing contrast, place of articulation, and position of plosives (*i.e.* within the syllable, word, or utterance) depending on the composition of the auditory message. These factors can lead to variation in speech that may hinder successful lexical access (Klatt 1986, Stevens & Blumstein 1978). Nonetheless, a number of researchers support that systematic variability in the speech

[2] Table 1 is based on information from Arvaniti (2010) and Carr (1999) for CG and English respectively.

signal contributes to the successful lexical access (Miller 1994, Warren & Marslen-Wilson 1987).

As a result, the first part of this study investigates whether phonetic environment can actually enhance or hinder the successful identification of plosives. Specifically, it attempts to identify which of the aforementioned factors have an influence on plosive identification as well as to provide a hierarchy of the difficulty in which the factors are to be ordered from the most influential that causes the most difficulties to L2 users to the least influential for the L2 context under investigation.

2. Types of errors, Second language phonology and speech perception

2.1. Types of errors

Collecting and describing samples of user language can be an effective way to investigate L2 acquisition (Ellis 1997). This may involve the types of errors L2 users produced and how these errors can change with time, or it may examine the developmental pattern L2 users follow, or it may look at the variability found in user language.

With reference to the first area (error analysis), this may involve four different steps, namely, the identification, description, explanation, and evaluation of errors. Identifying errors involves a comparison between what the user produces and what is thought to be normal or correct in the L2. After the errors have been identified, they can be described and classified into types. This can be achieved by classifying errors into categories or by identifying general ways in which the users' language differ from the L2. The next step is to try to explain why these errors occur. Specifically, errors can be systematic suggesting that L2 users may be able to construct a rule that is different from that of the L2 and which they apply regularly, or universal aiming at making the task of learning and using the L2 simpler. Universal errors may involve errors of omission and overgeneralisation, which are common to L2 users irrespectively of L1, as well as transfer errors in which L2 users attempt to use their L1 knowledge. The final step is to evaluate errors since some errors may be thought more serious than others affecting the speakers' intelligibility.

Therefore, the second part of this study focuses on analysing CG users' errors concerning plosives in the L2 English and specifically on identifying, describing, explaining, and evaluating these errors. CG users' errors regarding plosives appear to be explained by the fact that the phonological contrasts in the L2 involving plosive consonant voicing distinctions may be absent or noncontrastive in their L1. These types of errors are common only to users who share the same L1 or whose L1s manifest the same linguistic property.

2.2. Second language phonology and speech perception

Trying to account for the difficulties that CG users of L2 English encounter regarding plosive consonants, two approaches seem to be particularly promising. These involve the second language phonology approach and the speech perception approach.

On the one hand, second language phonology suggests that L2 users are able to construct a system of knowledge that refers to what they know (mental representation) and not just to what they can do. This system can be distinguished into two representational levels, segmental and prosodic phonology, which are not isolated from each other. Moreover, second language phonology is not isolated from other components of language such as morphology, syntax, discourse, and pragmatics.

Nonetheless, UG constraints such as the Critical Period Hypothesis (CPH) (Lenneberg 1967) and the unavailability of UG to adult L2 users suggest that L2 users can never achieve full competence and that their second language phonology system may manifest rules that are not permissible by UG. These cases of violating well established UG-constraints have led some researchers to propose that the acquisition of the second language phonology cannot reach ultimate attainment, being not fully UG-constrained (White 1989). However, the existence (or not) of properties not found elsewhere in natural languages cannot account for this since even data sets of known languages are amenable to infinitely many UG-incompatible treatments (Tomaselli & Schwartz 1990: 26-27) .

With reference to the CPH, there is a critical or sensitive period for language acquisition during which native-like competence can be achieved while beyond that period language acquisition becomes more difficult and incomplete. Evidence for L2 acquisition comes from studies of immigrants in the United States (Ellis 1997) that indicate that if the immigrants arrive before puberty they can achieve full competence in areas such as grammar and pronunciation than if they arrive after. However, the critical period seems to be different for grammar (about the age of sixteen) and pronunciation (about the age of six) (Ellis 1997). The theory of UG (Chomsky 1986) further supports the argument that L1 and L2 acquisition are different while L2 acquisition seems to be more difficult for adult users. Specifically, UG theory suggests that all languages share basic properties (principles) while they differ in terms of settings (parameters). Therefore, L2 acquisition is simply a matter of setting the correct parameters. The argument, though, is whether adult L2 users have access to UG. A number of theoretical positions has been formed to address this question including complete access, no access, partial access, and dual access (Ellis 1997). Specifically, the full access position suggests that full competence can be achieved since L2 users can switch to the L2 parameter setting (no critical period) (Ellis 1997). The no access position implies that full competence cannot be achieved since L2 users do not have access to UG but they depend on general learning strategies (Ellis 1997). Therefore, their second language may involve impossible rules by UG. The partial access position argues that L2 users may have access to some parts of the UG and L2 acquisition is guided partly by UG and partly by general learning strategies (Ellis 1997). Lastly, the dual access position states that adult L2 users employ both UG and general learning strategies but this may result in impossible rules by UG and an incomplete competence (Ellis 1997).

According to UG constraints, as a result, CG users' difficulties with English plosives may be attributed to a phonological deficit that results in the inability to distinguish between plosive consonant voicing distinctions (due to inaccurate representations of L2 speech sounds). Consequently, they tend to assimilate sounds that are not present or are 'phonological ungrammatical' (Dupoux et al. 1999) in CG to the closest acceptable form in their L1.

The speech perception approach on the other hand, suggests that acoustic cues are available that can assist the L2 users identify correctly the members of a phonological contrast. Since all language users share the same basic auditory function, these acoustic cues are available for both the L1 and L2 users. As a result, L2 users only need to learn to attend to the cue or set of cues that can lead to reliable identification of the members of an L2 contrast. Therefore, the difficulties that L2 users face are because they are not skilled at attending to these acoustic cues since L2 users are expected to exhibit some degree of L1 influence on their weighting of acoustic cues in perception. The reason for this is because phonological contrasts are realised in different ways acoustically. In the case of CG users of L2 English, these difficulties may be because CG does not have voiced plosives (Arvaniti 2006, Newton 1972a) or these are realised differently (prenasalised voiced plosives) (Okalidou et al. 2010, Newton 1972b) compared to English.

Consequently, the third part of this study aims at providing a convincing justification for the difficulties that L2 users face when it comes to plosive consonants. Specifically, it asks whether the difficulties are the result of second language phonology supporting a UG constraints account, the result of speech perception resulting from the phonetics of CG or the result of both.

3. Purpose of the study

The current study examined the identification problems of CG users of L2 English when it comes to plosive consonants within two contexts (word list and sentences). For the first developed task (Word Identification task) participants had to choose the correct answer from the two words provided based on what they heard. Their correct answers were analysed in terms of the plosives' voicing type, place of articulation, location within the word, and location within the syllable. The same procedure was followed for the second task (Words-in-Sentences Identification task) in which participants had to write down the word they heard. The only exception involved that the participants' correct answers were also analysed in terms of the plosives' location within the utterance. The findings of this first part of the study revealed which phonological environments make it more difficult for the L2 users to identify plosives.

The second part of the study involved only the second task (Words-in-Sentences Identification task). Nonetheless, the emphasis of this part was not on the actual words but on the target sounds. Participants' correct and incorrect answers were analysed in terms of voicing type (correct/incorrect voiceless and voiced plosives) and prenasalisation (correct/incorrect prenasalised plosives). The latter refers to clusters including a /nasal+voiced plosive/ consonant. The examination of the phonological environments of target sounds indicated what phonological processes are involved in the observed written responses. This information provided a close insight into the plosive system of CG a matter that constitutes a highly debatable issue.

Finally, the data obtained from the two tasks are discussed in relation to the approaches of second language phonology and speech perception. Specifically, both approaches attempt to provide a plausible or rational explanation of causal relationships among a group of observed phenomenon. In the CG context, certain expectations are formulated based on the two approaches that attempt to explain the causes why CG users of L2 English encounter so many difficulties with plosive consonants. According to the second language approach, thus, these difficulties are due to phonological deficits; on the other hand, the speech perception approach attempts to explain these difficulties as the result of the phonetics of the L1. The aim, thus, is to examine whether the two approaches can explain CG difficulties with L2 plosives and whether these approaches can actually complete each other rather than being contrastive.

4. Research Questions

Through descriptive and inferential analyses, the current study attempted to answer two questions.

Descriptive and Inferential Analyses:

Question 1: What are the factors that affect the identification of plosive consonants for CG users of L2 English?

a. What is the effect of consonant voicing in the identification of plosives?

b. How is the identification of plosives influenced by their respective place of articulation?

c. In which word position(s) (word-initial, -medial, -final) are plosives most easily identified?

d. In which position in a syllable are plosives more easily identified (onset/coda)?

e. In which position in an utterance are the words containing a plosive easier identified (beginning, middle, end)?

Question 2: What are the types of errors produced by CG users of L2 English involving plosive consonants?

The research approach for Research Question 1 was quantitative aiming at identifying the several factors affecting the identification of plosives as these were manifested in the two experimental tasks developed for the purpose of this study. Research Question 2 also involved a quantitative approach addressing the types of errors involving plosives that were produced for the second task.

5. Significance of the study

Research on the phonetics and phonology of CG is rather small involving three main topics that have been examined at some length (Arvaniti 2010). These topics refer to the geminates of CG, which remains the most well-researched topic in CG, the phonotactics of the variety, and the issue of opacity that may be observed due to 'glide hardening' where in some cases the vowel /i/ alternates with a palatal or velar plosive (Arvaniti 2010). As a result, this dearth of phonetic and phonological studies on CG seems to limit knowledge about the subject. Regarding plosive consonants, which is the main focus of this study, the only research known refers to existing voicing contrasts in SMG and CG and the corresponding characteristics in VOT by preschoolers (Okalidou et al. 2010, Okalidou et al. 2002). The perception of plosive consonants in L2 English by CG speakers, however, is an issue that calls for extensive investigation. Perceptual performance of CG speakers of L2 English and in particular performance linked to the voicing patterns of plosives is the main focus of this study. The aim of the present thesis, as a result, is to contribute as much as possible to limited knowledge about the phonetics and phonology of CG plosives and the differences and/or similarities with the English plosive system.

This study will add to an existing body of literature devoted to the phonetics and phonology of CG. The focus of this work will contribute to an understanding of the plosive system of CG that constitutes a highly debatable topic in terms of phonetic research. From a content perspective, the study will pragmatically be useful because it is specifically designed to provide a fuller understanding of the difficulties of CG users of L2 English regarding plosives in L2. Even though plosives are present in both CG and English, they have different identifications in the two linguistic codes since English has both voiceless and voiced plosives but CG has aspirated and unaspirated ones while there is much disagreement about the existence of voiced plosives. So, it would be of interest to examine how L2 users perceive phonological contrasts in the L2 that may be absent or noncontrastive in their L1, namely the factors that affect the identification of L2 plosives and the types of errors involving plosives, and if this is the outcome of second language phonology or speech perception difficulties.

Examining these different plosive systems will enable a prediction of the degree of difficulty L2 users may face when trying to master the L2 plosive system revealing which phonological environments make it more difficult for CG speakers of L2 English to perceive plosives in the L2. This could benefit both teachers and L2 users if they become more aware of L2 plosives especially with regard to specific phonological environments. This is a valuable asset for teaching an L2 and correcting users' errors since deviations are an inevitable part of the acquisition process. Exposing L2 users to a larger plosive system requires them to deal with more plosive consonants and in the case these consonants have allophones (*i.e.* $[p^h]$ for the phoneme /p/), then they have to cope with more variants forming new categories in the L2 language. From a pedagogical aspect, this implies a more difficult task for both the teacher and students. Nonetheless, the present study should encourage the design and implementation of specific materials and exercises in the L2 that concentrate on phonological environments of the target sounds.

6. *Definitions of Key Terms*

This study was an investigation of the difficulties CG users of L2 English encounter in regard to plosive consonants concentrating on the factors that affect the plosives' identification and on types of errors involving plosives in an attempt to interpret these difficulties as the result of second language phonology or speech perception.

Plosive consonants are sounds that are produced with complete closure of the articulators in question, which may then be released producing a sudden outflow of air. These consonants can further be identified by voicing (*i.e.* voiceless - voiced) and place of articulation (*i.e.* bilabial, alveolar, velar) (Oden & Massaro 1978).

Second language phonology refers to a mental representation system of knowledge (Archibald 1998). This system involves more than pronunciation and it is about what a language user knows rather than just what s/he can do. L2 phonology can be distinguished between segmental (*i.e.* consonants, vowels) and prosodic (*i.e.* syllables, stress) phonology (Archibald 1998). This study deals mainly with segmental phonology.

Speech perception can be defined as the process by which speech acoustic signals are mapped onto linguistic messages such as phonemes, syllables, words, and phrases. Nonetheless, acoustic variability arising from context, talker, dialect, rate, prosodic, and other differences (Diehl, Lotto & Holt 2004) can cause some difficulty in identifying sounds.

7. *Assumptions, Delimitations and Limitations*

Several assumptions were made for the purpose of this study. First, numerous factors tend to affect the identification of plosive consonants but the most influential seems to be the voicing contrast factor affecting most of the other factors. As a result, the answer to the difficulties L2 users of English face probably lies in the voicing contrast that seems to the real problem as revealed by most of the factors and the types of errors involving plosives. Secondly, difficulties at the perceptual level (speech perception) rather than representational deficits tend to be the primary reason for the CG users' problems regarding plosives. L2 users do not simply dismiss phonologically redundant acoustic information (non-contrastive phonetic information) since, as it was indicated, they were able to perceive voicing even though this is not a contrastive feature in their L1. Specifically, L2 users seem to be more successful in perceiving voiced plosives correctly when these are prenasalised compared to voiceless plosives. Therefore, the difficulties faced with plosives seem to be due to the fact that CG users tend to match the phonetic properties of the L2 signal to the L1 phonetic categories that mostly closely approximate them. This is attributed to perceptual similarity between English and CG since this is because English voiceless plosives are closer to CG voiceless plosives. Specifically, for English the voiceless plosive [p] has a VOT of 58ms, [t] has a VOT of 70ms, and [k] has a VOT of 80ms (Lisker & Abramson 1964). The VOT values of English voiceless plosives are closer to CG voiceless aspirated plosives than voiceless unaspirated plosives with 55ms for [p^h] versus 5ms for [p], 60ms for [t^h] versus 17ms for [t], and 65ms for [k^h] versus 22ms for [k] for adult users of CG (Tserdanelis & Arvaniti 2001, Arvaniti 1999).

This study is delimited by its focus on L2 users at a beginner's level in an academic setting, so results may not be generalisable to L2 users at an intermediate or advanced level. The study is also delimited to the identification of plosive consonants in the formal contexts of a word list and short sentences not examining other consonants or casual communicative speech. Regarding the second task, this study is delimited by the time constraints. Even though this was a longitudinal study, the second task was used only during the third semester of the research period while for the two first semesters only the first task was used. The words used in testing were low-frequency words while the test instruments were developed through consultation with two linguists, namely, Dr Panagiotidis from the University of Cyprus and Dr Petinou from the European University Cyprus, Nicosia.

The limitations in this study include the fact that the two tasks were pre-recorded by a native English speaker and participants had to identify the target sounds as well as distractors within words and sentences. Further, the participants were limited to CG users of L2 English at a beginner's level attending a B.A. programme in Business Administration or a B.Sc. programme in Business Computing, so results may not be applicable to L2 users of an intermediate or advanced proficiency. A further limitation involves the access to only one specific institutional site for data collection. The limited geographic diversity of the data collection site probably has an influence on the generalisability of the findings even if the specific college was attended by students from different areas of Cyprus (*i.e.* Nicosia, Limassol, Paphos). These students were included in the sample but they made up only a minority. Finally, identification problems observed to be typical of CG users of L2 English may differ from those of L2 users from other countries since the study is not designed as a comparative study.

8. Organisation of the study

Following this brief introduction, the dissertation consists of five sections. Chapter 2 introduces the existing literature on the two approaches, namely second language phonology and speech perception. Specifically, it includes a historical perspective on the development of second language phonology studies, including a discussion of linguistic constraints. In an effort to provide an explicit theory about the interrelationship of the various linguistic constraints, the Ontogeny Model and the Ontogeny Phylogeny Model (Major 1987a, 2001) are presented. The Ontogeny Phylogeny Model is a revision of the Ontogeny Model that addresses the L2 component, since the first model did not refer to the L2 component. After the two models are presented, there is a review of the main causes of second language phonology fossilisation. This is followed by a discussion of the speech perception approach reviewing the observations shaping theoretical thinking as well as the different theories that exist for speech perception on a phonemic categorisation level, and a phonemic categorisation and lexical knowledge level. The section on speech perception concludes with a discussion of speech perception in L2. The third section of chapter 2 concentrates on the CG dialect proceeding to a comparison of the phonological systems of CG and English. The last section of the chapter introduces plosive consonants and their characteristics that constitute the focus of this research.

Chapter 3 outlines the design of the longitudinal study. The research task, questions, and hypotheses are stated in more detail and the quantitative approach is outlined. The institutional site and participants are described and methodological and analytical choices are stated. Further, the research design is evaluated in terms of the validity and reliability of the method and the ethical concerns taken into consideration.

Chapter 4 presents the results of the longitudinal study following the two research questions. First, there is an attempt to document the participants' level of proficiency in English. Second, the numerous factors that affect the identification of plosives are explored as these are revealed via the two tasks and an indication of the rank order for these factors is provided in order to see what factor has the greatest influence on plosive consonant identification. Thirdly, the types of errors produced by the participants regarding plosives for the second task are described.

Chapter 5 discusses the research questions in light of the two tasks' findings. This provides a close insight into the factors that actually affect the identification of plosives in L2 English (first and second task) as well as the types of errors produced by the participants (second task). The key findings of the study are compared to previous research findings while there is an attempt to synthesise the results of both tasks in relation to each other. Finally, L2 difficulties regarding plosives are interpreted according to second language phonology and/or speech perception.

In chapter 6, the key findings are summarised and the contribution of the work to understanding of L2 phonological organisation is considered. The chapter concludes that speech perception is a very important source that contributes to repairs of L2 structures and that the difficulties of CG users with L2 plosives could be a result of misperception rather than phonological deficits. Finally, some ideas for future research are proposed.

Summary

This chapter introduced the research topic by stating the general research questions that this study is concerned with, namely the questions of 1) what are the factors affecting the identification of plosive consonants /p b t d k g/, and 2) what types of errors involve plosives. These difficulties of CG users with L2 plosives are thought to be explained in terms of second language phonology or speech perception. A brief overview of the plosive system for both linguistic codes was provided to clarify the identification tasks involved. Given the two systems, the CG users of L2 English will have to 'split' one native consonant category (or two since this is a highly debatable issue in CG) into more to successfully acquire English phonology. The two approaches that attempt to explain these difficulties regarding plosive consonants as well as the characteristics of plosives are examined in chapter 2 that follows.

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

Second language acquisition (SLA) research investigates how proficiency is attained in a language acquired subsequent to the L1 (first language). During the 1950s and 1960s, the emphasis of SLA was pedagogic, namely, on improving the ways in which a L2 (second language) was taught. Nonetheless, from the 1970s on there has been a shifting emphasis from the teacher to the language user. This can be attributed to the changes occurring in the areas of linguistics, psychology, and L1 acquisition that are of crucial importance for SLA study. These areas 'shifted focus from the external to the internal in the 1960s' (Archibald 1998: 1). The outcome was that linguistics started to account for what the adult L2 users[3] try to acquire (L2) and what they know already (L1). The emphasis of psychology was placed on how users acquire knowledge while L1 acquisition started providing several findings that can productively be applied to SLA.

This chapter provides an overview of the major issues and findings in research on second language phonology, which is the focus of this study. First, theory and research on linguistic constraints is presented with reference to developmental effects, L1 transfer, markedness, and linguistic environment. Research and the approach of second language phonology, the causes for fossilisation of the L2 pronunciation, and two models for L2 phonological acquisition based on the interaction of transfer and developmental factors are discussed. Additionally, research on speech perception is addressed and the major theories of speech perception are presented referring to a phonemic categorisation level, as well as a phonemic categorisation and lexical knowledge level. Thirdly, Cypriot Greek (CG) that constitutes the context under investigation is introduced and an overview of the CG and English phonological systems is provided. Lastly, plosive consonants are addressed and examined in a phonetic, lexical, and sentential context in an effort to investigate how the different context may affect the identification of the plosives.

[3] Bilingualism, that is thought to be a sub-discipline of SLA research, is concerned with SLA in children.

1. Second Language Phonology

1.1. Investigating Second Language phonology

The acquisition of an L2 appears to be *somehow* different compared to the acquisition of an L1. The reason is because adult L2 users do not seem to be able to achieve the same native competence as L1 children; similarly, children never have as many difficulties as L2 users do. These differences between L1 and L2 acqusition are probably more evident when it comes to the acquisition of second language phology. L2 users may face many difficulties when it comes to the acquisition of pronunciation and intonation patterns in the L2. The source for these difficulties is often suggested to be UG and the fact that it does not operate in L2 acquisition. Nonetheless, other factors may be responsible. According to White (1989), in addition to UG, sufficient input and various mechaninsms are also relsponsible for L1, and probably for L2, acquisition.

The fact that L2 users come to the task of acquisition already knowing a language may also contribute to these difficulties. Specifically, it seems to be considerable debate about the role of the L1 while the influence of L1 may not be absolute. In other words, some aspects of L1 may prevent successful acquisition of specific L2 structures whereas other L2 properties may be acquired with little or no interference from the L1.

However, second language phonology, which is the focus of this work, constitutes an area of investigation that was long neglected by SLA research. Schumann (1976), in an effort to summarise research on SLA, pointed to this lack of studies on second language phonology. The reason was that looking closely at the phonological system of an L2 user was not believed to provide useful insights into the nature of SLA process. Phonological errors were simply thought to be the result of negative transfer from L1 into the L2 system. Nonetheless, L1 transfer 'is only a part -and often a small part- of the influence' (Tarone 1978: 70) on second language phonology. Other sources include the universal tendencies in L2 phonology, the significance of markedness in forming the second language phonological rule system, and the variation in phonological development that is the outcome of social and psychological factors. A second reason for the lack of studies on second language phonology was the thought held by L2 researchers, teachers, and students that the phonological system of the L2 users could not provide useful insights into the nature of the L2 acquisition process (Tarone 1978). Nonetheless, acquiring the phonological system (sound system) of an L2 is as essential as acquiring the grammar system and vocabulary of the relevant language. Phonology is the study of certain types of mental category, mentally sorted representations, and generalisations concerning those categories and generalisations (Carr 1999), which is fundamental for communicating in an L2. A L2 user 'must learn to represent and implement information related to such things as the segmental inventory, phonotactics, syllable structure, stress, rhythm, and intonation of the language in question. Each of these phenomena are highly complex in both the L1 and the L2' (Archibald 1998: 37).

Hence, in the last few decades second language phonology started to receive more emphasis (McCarthy 2002, Hancin-Bhatt 2000, Broselow, Chen & Wang 1998, Hancin-Bhatt & Bhatt 1997, Pater 1997, 1989, Prince & Smolensky 1993, Broselow & Finer 1991, Ioup & Weinberger 1987, Tarone 1987, 1984, Broselow 1983) in an effort to investigate the extent to which the L1 and L2 sound systems affect the phonological acquisition of an L2.

1.2. The Acquisition of Phonology

The study of phonological acquisition in L1 constitutes a field that has undergone significant changes and has been developed over the years. Early work on phonological acquisition (1870-1960) involved diary studies and large studies. The former concentrated on the behaviour of one or two children, aiming at describing their segmental and word-level phonological development (*i.e.* Smith 2010, 1973, Velten 1943, Leopold 1939-1947, Grégoire 1937, Stern & Stern 1907, Preyer 1889). The obvious limitations of this descriptive perspective (*i.e.* objectivity, accuracy, training of observer) led to the rise of behaviorist perspectives involving large sample studies of language development (*i.e.* Templin 1957 with 430 participants). Under behaviorism, the development of children was thought to be determined and shaped by the environment in which the children imitated what they heard in order to communicate (Bloomfield 1933). Large studies, however, are not very informative about how an individual child acquires the phonology of a language.

In Europe, the emphasis seemed to be on the phoneme rather than on surface segmental contrasts (de Saussure 1916). Trubetzkoy (1939) and Jakobson (1941) upheld this notion going beyond phonemic inventories, thinking of language in terms of phonological systems (Demuth 2011). Specifically, Jakobson (1941) suggested that language users first acquire a 'maximally different set of unmarked contrasts' a notion that has generally been upheld (Lindblom 1992, Locke 1983) even though it has not been verified at the segmental level (Velten 1943).

New research suggested that language could not be acquired merely from interactions with the environment since input could sometimes be incomplete or contradictory. This was in direct contrast to the behaviorist approaches to language acquisition supporting that language development is determined and shaped by the environment since children imitate what they hear in order to communicate. As a result, the nativist or rationalist approach (Chomsky 1965, 1957) put forward the notion of abstract, underlying representations in syntax and argued that language users are constrained by a set of universal underlying principles that guide the language acquisition.

The structuralist focus was on surface phonological feature contrasts, while suprasegmental phenomena were not explained. This gave rise to generative phonology (Chomsky & Halle 1968) suggesting that '[a]s in the case of syntax, it was realized that an adequate theory of phonology must characterize what a speaker (and learner) knows about the sound system of the language at an abstract level of phonological representation' (Demuth 2011: 573).

During the 1970-1980s, studies on the acquisition of phonology used either a generative approach where children's early productions were accounted as a set of phonological rules (Smith 1973) or a cognitive and biological approach to individual differences (Vihman 1996, Lindblom 1992, Ferguson & Farwell 1975). Nonetheless, the generative approach seemed to be inadequate to deal with several phonological processes in language and in acquisition while an autosegmental approach[4] (Goldsmith 1995, 1989, 1979) seemed to be more adequate for dealing with such processes. With reference to the cognitive approach, Ferguson and Farwell (1975) suggested that individual differences in children acquiring the same language were evidence of a cognitive strategy to language acquisition where children were 'hypothesis testers' investigating the articulatory space in an attempt to produce specific segmental contrasts. According to Ferguson and Farwell (1975), however, universal phonetic tendencies were also present in children's productions, which were thought to be constrained by the vocal tract and central nervous system biology.

In the 1990s, Optimality Theory (OT, Prince & Smolensky 2004, 1993) changed the focus of attention. OT does not make a distinction between segmental and prosodic phonology, which means that it can express interactions between both but also that it cannot restrict the possible interactions. Further, 'the 1990s also saw the beginnings of more

[4] Autosegmental approach suggests that different aspects or levels of language are structured in their own way but are associated with all other levels.

interdisciplinary research on phonological acquisition' (Demuth 2011: 578). Infant-speech perception and computational approaches to learnability (*i.e.* computerised corpora from children) started to interact with language acquisition providing more information on the nature of constraints on early phonological grammar and the changes that occur over time.

Early research on L2 phonological acquisition (1950s-1960s) also focused on a segmental level. The Contrastive Analysis framework (*henceforth* CA) seemed to be the dominant theory of L2 acquisition of the time (Hammerly 1982, Stockwell & Bowen 1965, Lehn & Slager 1959, Lado 1957) deriving from behaviorism (in psychology) and structuralism (in linguistics). CA involved the systematic comparison between L1 and L2 inventories for predicting areas of learning difficulty in terms of L2 segments. Under this approach, L2 users had to acquire one by one a fixed set of habits through an imitation and reinforcement process while L1 experience influenced significantly the acquisition of L2 segments. Nonetheless, this approach could not account for the performance levels of L2 users on different L2 segments that were not present in the L1 inventory. L2 users, however, were able in some cases to approach nativelike attainment even though CA predicted that these sounds would be problematic. Further, it could not account for the fact that L2 users from different L1 backgrounds would substitute different sounds for an L2 sound as in the case of Chinese and Russian L1 speakers who substituted /s/ and /t/ respectively for /θ/ (Hancin-Bhatt 1994). The reason for these limitations was the level of phonological representation for comparing the two languages where the emphasis was on the phoneme as the relevant unit of analysis (Brown 2000).

Research on L2 phoneme acquisition was then influenced by generative phonology emphasising on differences and similarities in distinctive features between the L1 and L2 (Michaels 1974, 1973, Ritchie 1968). According to this approach, difficulty with L2 sounds could be interpreted in terms of featural differences between the L1 and L2, combined with the biases in perception of the L2 users (Brown 2000). Apart from distinctive features, underlying representations, rules, and derivations were also employed to account for L2 utterances (Eckman 1981a, 1981b). With the rise of non-linear approaches, prosodic hierarchies (Zampini 1997), metrical grids (Archibald 1993a, 1993b, 1993c, James 1986), and Feature Geometry[5] (Brown 2000, 1998) tried to interpret L2 phonology. Recent research on L2 phonology shifted its focus from rule-driven to constraint-based approaches (Eckman 2004).

[5] Feature Geometry uses feature trees or geometries to represent privileged feature classes.

Specifically, there is an attempt to explain L2 pronunciation within the framework of OT (McCarthy 20002, Hancin-Bhatt 2000, Broselow, Chen & Wang 1998, Hancin-Bhatt & Bhatt 1997, Prince & Smolensky 1993) as the result of constraint rankings and rerankings of the L2 users.

1.3. Linguistic Constraints

A major question that has often occurred in L2 phonology literature has been how to explain phonological errors and learning difficulty. Research has indicated a number of factors such as language universals (Pater 1997, 1989, Broselow & Finer 1991), developmental processes (Cardoso 2007, Major 2001, 1987, Abrahamsson 1999, Carlisle 1997), L1 transfer (Lombardi 2003, Hansen 2001, Major 2001, 1987a, Broselow, Chen & Wang 1998, Eckman 1977, Lado 1957), markedness (Han 2009, Eckman, Moravcsik & Writh 1989, Eckman 1996, 1981, 1977), age (Long 2007, Mayberry & Lock 2003, Ioup & Tansomboon 1987, Lenneberg 1967), and sociolinguistic variability (Beebe 1980, Schmidt 1977, Dickerson 1975). All the above have been found to be related in some way to second language phonology.

1.3.1. Linguistic Universals

An area of research for looking for constraints on L2 phonology has been linguistic universals. The two main approaches put forward for linguistic universals involve typological universals (Greenberg 1966 in Ellis 1994) and Universal Grammar (UG, Chomsky 1986). The former refers to cross-linguistic comparisons of languages in an attempt to discover common features. Specifically, Greenberg (1960 in Evans & Levinson 2009) distinguished between four types of universals (Table 2) that are not intended as 'a static set of principles, but rather relational and diachronic' (Greenberg 1991: 41). An example of Type 1 universals may involve the fact that all languages have nouns and verbs or that all languages have sound systems and distinguish between consonants and vowels (Greenberg 1986 in Evans & Levinson 2009). An example of Type 2 universals can be the fact that most languages have nasals (Evans & Levinson 2009). Nonetheless, there are several problems with the abovementioned universals. Specifically, Type 1 universal does not take into account sign languages, the fact that vowels in oral languages may not be audible, or that in some languages such as the Northwestern Caucasus, vowels exist only in a few minimal pairs involving mainly loanwords from Turkish or Arabic. For Type 2 universals, exceptions may include Salish (Evans & Levinson 2009).

On the other hand, conditional or implicational universals of Types 3 and 4 allow making hypotheses about the interrelation of ‘two, logically independent parameters […], therefore, greatly restrict the space of possible languages’ (Evans & Levinson 2009: 438). Examples can be statements such as (a) IF a language has nasal vowels, THEN it has oral vowels or (b) IF a language has a trial number, THEN there is also a dual. IF there is a dual, THEN there is also a plural (Evans & Levinson 2009). Whereas statement (a) expresses the ‘markedness (or recessive character) of nasal vowels’ (Evans & Levinson 2009), statement (b) does not seem to hold for Nen, where the basic stems of verbs in the language are dual while a suffix indicates either singular or ‘three-or-more’ (Evans & Levinson 2009). Absolute universals, thus, unconditional or conditional tend to become statistical universals as more languages are tested (Evans & Levinson 2009). As a consequence, Dryer (1998) suggested that statistical universals or strong tendencies are more interesting cases. Specifically, most work done in linguistics typology involves Type 4 universals (Evans & Levinson 2009). In the case these tendencies are weak, they indicate bias in either the languages or employed sampling methods (Evans & Levinson 2009). In the case they are strong, they suggest that there is ‘a cognitive, communicative, or system-internal bias towards particular solutions solving’ (Evans & Levinson 2009: 439).

	Absolute (exceptionless)	Statistical (tendencies)
Unconditional (unrestricted)	Type 1. “Unrestricted absolute universals” *All languages have property X*	Type 2. “Unrestricted tendencies” *Most languages have property X*
Conditional (restricted)	Type 3. “Exceptionless implicational universals” *If a language has property X, it also has property Y*	Type 4. “Statistical implicational universals” *If a language has property X, it will tend to have property Y*

Table 2: Logical types of universal statement (following Greenberg)

With reference to L2, ‘many of Greenberg’s implicational statements are completely in accordance with current theoretical descriptions of the syllable; consequently, the L2 research based on those implicational statements offer evidence for the influence of syllable structure universals on the structuring of [second language] phonology’ (Carlisle 2001). Specifically, it is suggested that the CV syllable is an absolute universal in languages (Greenberg 1965). Also, the markedness of margins for both onsets and codas seems to increase with length, as indicated with the fact that the presence of onsets and codas of length /n/ in languages implies the presence of at least one subsequence /n/-/l/ in the corresponding position (Greenberg 1965). The only exception for this generalisation involves the fact that the presence of CV does not necessarily mean that a V has to be present (a syllable with zero onset) (Greenberg 1965). Greenberg further documented implicational relationships between pairs of consonant clusters suggesting that complex margins with a sharper rise in sonority are preferred (Carlisle 2001).

Universal principles, as a result, seem to participate in L2 acquisition along with other external factors:

> "the varying social conditions under which second language acquisition takes place, the accidental facts of individual experience, and other variables mean that the process is not one of mechanical application of principles to clearly analyzable situations, but rather the disentangling of a complex web of simultaneously acting causal factors" (Greenberg 1991: 41).

Nonetheless, it seems that L2 adults who are completely involved in the L2 environment are not able to achieve nativelike attainment in the L2, regardless of any external influence.

Consequently, the approach employed by Greenberg (1966 in Ellis 1994) involves testing language universals against the ‘diversity of languages’ while suggesting that many of these universals apply to L2 acquisition as well (Carlisle 2001). Specifically, unmarked features seem to be universal or present in most languages while L2 users tend to transfer them contrary to marked features. This implies that unmarked features are acquired earlier and easier in both the L1 and L2. On the contrary, the approach employed by Chomsky (1980) suggests that linguistic universals can be extracted from the study of a single language:

> I have not hesitated to propose a general principle of linguistic structure on the basis of observation of a single language. The inference is legitimate, on the assumption that humans are not specifically adapted to learn one rather than another human language. . . . Assuming that the genetically determined language faculty is a common human possession, we may conclude that a principle of

> language is universal if we are led to postulate it as a "precondition" for the acquisition of a single language. (48).

As a result, UG within a generative approach examines individual languages in great detail in order to identify principles of grammar that underlie and govern specific rules. These innate constraints are part of the Language Acquisition Device (LAD), a language-specific and genetically determined system guiding L1 acquisition. This system is said to be at work for L2 acquisition as well suggesting that UG is equally available to L2 users (Corder 1992, White 1992, Flynn 1986, van Buren & Sharwood-Smith 1985) even though strong limitations seem to reduce its effectiveness and availability. Nonetheless, there are still controversies on whether or not UG is available to adult L2 users or if L1 and adult L2 acquisition involve different learning mechanisms (Cook 2009).

In an effort to account for language acquisition, UG distinguishes between 'core' and 'peripheral' grammar. 'Core rules' are innate and, therefore, governed by UG involving unmarked features while 'peripheral rules' are not governed by universal principles involving marked features (Cook 1985). As a result, UG, just like typological universals, implies that unmarked features can be acquired earlier and easier in the L1 and L2 while marked features require more time and effort by the L2 users.

Chomsky (1965) further argues that there are two types of language universals, the substantive and the formal universals. The former refer to the substance of linguistic elements and can be extracted from a fixed class of items such as distinctive phonological features and cannot be falsified by finding a language without a specific substantive universal since that universal is not required in all of them. What can be done in the case in which a language has a different universal is to simply add it to the inventory of the substantive universals. Formal universals specify abstract constraints in languages. For instance, languages can have specific rules or they cannot have rules performing specific operations.

An example of abstract constraint may involve Subjacency (Newmeyer 2004), which is a constraint on movement suggesting that wh-movement may not cross more than one bounding node, but it may cross one (Chomsky 1973). This constraint attempts to explain why sentences like 'Where did John say *that* we had to get off the bus?' and 'Did John say *whether* we had to get off the bus?' are grammatical while the sentence 'Where did John say *whether* we had to get off the bus?' is not (Evans & Levinson 2009). Children seem to be able to infer which sentences are possible and which are not, without explicit instruction because of the universal subjacency constraint. However, this constraint may not work in specific languages such as Italian or Russian in the same way resulting in children having to acquire the specifics of the constraints (Evans & Levinson 2009). Versions of parametric theory are meant to address this issue suggesting that exposure to language triggers the parameters to adopt the correct setting. Nonetheless, the process of how children are able to acquire the specifics of a constraint is still unclear (Newmeyer 2004, Van Valin & LaPolla 1997). Newmeyer (2004) argues against the notion of parameters of UG and proposes that 'language-particular differences are captured by differences in language-particular rules' (183) while Van Valin and LaPolla (1997) support that this process may significantly be affected by human communication and cognition. As a result, each constraint in UG must be thought as 'a working hypothesis […] that could be falsified by cross-linguistic data' (Evans & Levinson 2009).

In support of the universalist approach, however, many studies have been done on the availability of the UG in L2 acquisition and the availability of parameter setting concluding that L1 children and L2 users have access to UG since they are able to pick a value allowed in natural languages but this is an intermediate value, which is neither the L1 or L2. This explanation can account for parametric variation, which refers to how aspects of constraints may differ from language to language and it is an important issue addressed by different versions of parametric theory. A study that provides evidence for parametric variation was conducted by Broselow and Finer (1991) dealing with L2 pronunciation at the segmental level. The study used the parameter of Minimal Sonority Distance (MSD) to account for the performance of twenty-four Korean and eight Japanese users of L2 English on the production of onset clusters. The results indicated that the L2 users did not transfer the value of the MSD parameter of the L1 nor did they demonstrate L2 values of the parameter. As a result, Broselow and Finer (1991) concluded that the performance of the L2 users was somewhere between the L1 and the L2 settings.

In similar terms, Pater (1997) carried out a study involving the acquisition of stress patterns in L2 English by L1 French users. The parameters of word headedness and directionality were found to be set in a way that it was neither nativelike nor targetlike, but which was allowed by UG. Similar results were also reported by Pater (in the work of Baptista 1989) for Brazilian Portuguese users of L2 English.

Despite these findings, researchers such as Tomasello (1995) suggest that innate concepts and structures should be the 'last resort'. Several reasons have been provided to justify this claim. Evans and Levinson (2009) suggest four main reasons. First, other mental capacities such as memory, action control, and sensory integration may be responsible for common properties in languages (formal universals that are independent of the meaning of words). Second, common properties may be due to 'overall design requirements of communication systems' (Evans & Levinson 2009: 439). Third, common properties may be attributed to functional factors, namely, 'the matching of structure to fit the users which it would be put' (Evans & Levinson 2009: 439). Lastly, 'given human motivations, interests and sensory perception together with the shared world we live in, we can expect all sorts of convergences in, for example, vocabulary items' (Evans & Levinson 2009: 439). An example constitutes the fact that all languages have a term to express concepts such as the family and its members.

Consequently, criticism against the universalist approach caused 'the shift […] toward a new model of acquisition, one that focuses on a new and different type of universals' (Macken & Ferguson 1981: 7). This shift was the result of the accumulation of data that could not be accounted by the universalist linguistic models and which 'document the existence of significant, widespread individual differences between children acquiring the same language and show that the acquisition process, in certain aspects, is not, as assumed by the universalist model, a linear progression of unfolding abilities' (Macken & Ferguson 1981: 7). The model of acquisition that was proposed was a cognitive model (Ferguson & Macken 1980, Fey & Gandour 1979, Kiparsky & Menn 1977), which was more flexible compared to the deterministic linguistic model. The emerging model allowed the user to actively hypothesise on the input data, test, and revise these claims, and construct a complex system or 'grammar' based on the earlier simpler ones (regularisation). As a consequence, whereas the universalist theories aimed at identifying universal constraints resulting from linguistic constraints (language, articulatory and perceptual systems), this model takes into account the universal cognitive, problem-solving abilities of the user.

Evans and Levinson (2009) suggest that language universals are 'vanishingly few' given the diversity of languages and levels of linguistic organisation (*i.e.* sound, meaning, syntactic organisation). As a result, recurrent patterns in organisation of languages seem to be better accounted as reflecting 'cultural-historical factors and the constraints of cognition' (Evans & Levinson 2009: 429) rather than language universals. Smith (2010) also emphasises on cognitive ability since infants from an early age are 'sensitive to statistical properties of the input language and are able to extract relevant information from it' (13). Further, Saffran, Newport and Aslin (1996) suggest that 8-month old infants can identify three-syllable words based on the relative frequency of these sequences while this ability generalises to other domains as well such as music (Saffran 2001). The significance of cognitive constraints has also been stressed by Nevins (2010) in a study that used artificial grammar learning. The study aimed at examining two universals in the phonological systems, namely the privileged position of edges in intersyllabic processes and the asymmetric roles of consonants and vowels in intersegmental processes (Nevins 2010). As a result, the first experiment examined the universal dispreference for specific unattested precedence-modifying operations in ludlings (language games) while the second experiment looked at a universal dispreference for consonantal repetition compared to vowel repetition since consonants are more likely to dissimilate. Artificial language learning was used for both experiments in an effort to investigate the relative ease of learnability and generalisability of unattested grammatical patterns. In that manner, unattested grammatical patterns could be identified as the result of pure historico-geographic accident or as the result of UG. The findings suggested that unattested grammatical patterns were due to the latter and specifically to cognitive constraints on the form of linguistic grammars.

Both of the hypotheses outlined above, namely universals and the cognitive model, provide useful insights into SLA research. Specifically, in the case of children an L2 acquisition model needs to take into consideration the cognitive developmental stage of the L2 user as well as prior linguistic knowledge and the learning context. Also, substantive cross-linguistic similarities of L2 acquisition are expected to occur 'in situations where similarities in these factors exist in the L2 situations being compared' (Macken & Ferguson 1981: 19). To another matter, 'probability statements of phonological development do not predict individual cases as exceptionless universals would, and a developmental L2 model based on such probabilities (from L1 research) is correspondingly limited' (Macken & Ferguson 1981: 19). Finally, the user especially children are able to recognise patterns in the effort to master a language regardless of adult error correction or child-self-correction.

1.3.2. Developmental Processes

Having in mind the cognitive model, a new set of universals was proposed that were added to the language universals and which appear to be parallel in L1 and L2 acquisition.

Specifically, it was suggested 'between adult speech sounds and the corresponding child speech sounds during the period of greatest phonological development, typically between one and a half and four years of age' (Macken & Ferguson 1981: 8), there are phonetically systematic relationships that are thought as instances of 'phonological processes' (PP) in operation (Oller 1975). The universal significance of PPs, as a result, is because these 'universally appear in operation at this age [while] some processes are extremely common across many languages and many children, while others are more likely in particular languages or are favored by particular children' (Macken & Ferguson 1981: 8). Some of the PPs in L2 acquisition bear a resemblance to those of child language development (L1) while others are transfer processes from the L1 (Macken & Ferguson 1981). These PPs involve the processes of substitution, syllable structure, assimilation, and reduplication. With reference to L2, these PPs may be explained in terms of reactivation of L1 strategies or processes, transfer processes or universal or language-specific constraints or even factors such as social constraints.

Research on L2 substitution processes in which one segmental sound is replaced by another focuses on the interaction of developmental and transfer PP. A study on phonology conducted by Mulford and Hecht (1980) investigated this interaction in the phonology of a child acquiring L2 English. Steinar, a 6-year-old boy from Iceland, used to devoice and strongly aspirate final English plosives since both of these processes were quite common in his L1. The researchers proposed two possible explanations for this phenomenon. Based on the first one, the most persistent substitutes are those predicted by both transfer and developmental processes. The second was based on the two processes' role that may differ depending on the involved part of the phonology (Table 3).

Vowels liquids plosives fricatives and affricates

←→

transfer processes predominate developmental processes predominate

Table 3: Continuum indicating the relative roles of the two kinds of processes

According to Wode (1978, 1977), children acquire the L2 phonology 'through the grid of their L1 system' and their L1 developmental stage and matching processes, through which they identify similar and non-similar elements between the L1 and L2, are essential. In particular, similar elements are substituted while for non-similar elements, children have natural developmental sequences just like those of L1 users.

L2 syllable structure processes were examined by Tarone (1976). By analysing the speech of two Cantonese, two Korean, and two Portuguese speakers of L2 English, she came up with various syllable structure errors. These involved consonant deletion, epenthesis, and glottal plosive insertion (in a vowel sequence). Even though most errors were explained in terms of either transfer or development, there were cases as with epenthesis in which the amounts were higher compared to L1 acquisition. This tendency was explained in terms of a universal preference for CV syllables.

Assimilation processes involve assimilating sounds to neighboring sounds either in the same word or other unit and are a common type of PP in L1 acquisition. For instance, an L1 child may say 'guck' [gʌk] for 'duck' [dʌk] (Macken & Ferguson 1981) assimilating the initial alveolar plosive to the velar plosive later in the word. However, these processes are uncommon in L2 acquisition since an L2 user would rarely say 'guck' for 'duck'. Reduplication, just like assimilation processes, seems to be more evident in L1 than in L2 acquisition and is characteristic of child language. L2 words rarely have identical or partly identical CV syllables repeated. Nonetheless, in L1 acquisition these may involve extension of adult monosyllables as in *ball* [bʌbə], modification of adult replications as in *bye-bye* [dɛdɛ], or of an adult non-replication word as in *water* [wɔwɔ].

Consequently, the common PPs operating in both the L1 and L2 acquisition probably reflect universal constraints of speech perception and production systems, coupled with developmental processes. Other L2 PPs are the outcome of transfer reflecting the L1 phonological structure, while others may represent universal or language-specific constraints of language-external factors. As a result, further research on the interaction of these different types of processes can provide valuable information.

1.3.3. L1 Transfer

A major focus in L2 acquisition has been the influence of L1 in L2 speech acquisition (Leather & James 1991) that seems to be most prevalent than in the other subsystems of language (*i.e.* morphology, syntax, pragmatics). According to Odlin (1989), '[t]ransfer is the influence resulting from the similarities and differences between the target language and any other language that has been previously (and perhaps imperfectly acquired' (27). As a result, L2 users tend to depend on the sound system of their L1 when pronouncing the L2.

Contrastive analysis (CA) of the L1 and L2 phonologies was originally used for predicting L2 pronunciation errors (Eckman 1977, Lado 1957). These errors were thought to be the result of negative transfer from L1. At this point a distinction between positive transfer, negative transfer, and divergent negative transfer (Tarone 1978) seems mandatory. Positive transfer occurs when both the L1 and L2 have an identical phoneme as in the case of /t/, implying no difficulty with the specific L2 sound. Negative transfer or convergence is when the L1 has two phonemes as in the case of /f/ and /v/ but in the L2 these are variants of a single phoneme as in the case of /f/. Nonetheless, the L2 user is not confronted with the task of making or hearing a new L2 distinction. Lastly, in divergent negative transfer the one L1 phoneme /l/ equals to two L2 phonemes /l/ and /r/ and the user needs to learn to discriminate between them.

Trying to measure negative L1 transfer involved presenting L2 sounds and words in isolation in an effort to investigate how L2 users perceive or produce the target sounds. For instance, Tarone's work (1987) on syllable structure supports L1 transfer from Korean, Cantonese, and Brazilian to L2 English. Specifically, most errors produced by the participants in word-final consonants were due to L1 transfer effects, with Cantonese and Korean participants favouring deletion and Portuguese favouring epenthesis. These results were confirmed in Sato's study (1984) involving L1 Vietnamese and L2 English. The results indicated that Vietnamese syllable structures favouring closed syllables were preferred over open syllables while participants were proceeding to more errors in terms of word-final consonant clusters than word-initial consonant clusters.

Final consonants were the focus of Flege and Davidian (1984), Major (1987a), and Hodne's (1985) studies. More specifically, Flege and Davidian (1984) studying Spanish, Polish, and Mandarin Chinese speakers pointed out that the participants were more likely to delete final plosives especially speakers of Spanish and Mandarin Chinese whose languages do not allow final plosives to occur. Positive and negative transfer were demonstrated in Major's study (1987a) investigating L2 English final consonants and consonant clusters by L1 Japanese speakers. Voiceless obstruent cluster production was effortlessly produced by the participants (positive transfer) who, however, experienced great difficulties with consonant clusters involving liquids (negative transfer). Two Polish speakers of L2 English were the focus of Hodne's study (1985) in which 83% of the errors produced by the speakers involved word-final consonants.

Broselow (1987) also highlighted the importance of transfer as well as the transfer of specific rules such as epenthesis from L1 Arabic into L2 English. Morphologically restricted rules, though, seemed not to transfer. In Benson's study (1988) of Vietnamese speakers of L2 English, closed word-final consonants were changed into CV syllables that were in majority attributed to transfer. In similar lines with Benson's study was the study conducted by Osburne (1996) in which consonant clusters in L2 English were reduced by Vietnamese speakers.

By studying four Hungarian speakers of L2 English, Vago and Altenberg (1977) indicated that phonetic transfer influenced the production of English sounds that were not present in L1. In particular, all L2 users tended to substitute the L1 phoneme /d/ for the English phoneme /ð/ because of acoustic or articulatory similarity. Altenberg and Vago (1987) also examined L1 Hungarian and L2 English with emphasis on the English consonant and vowel production. Their results pointed to the phonetic and phonological transfer influencing the speakers' L2 production.

Major and Faudree (1996) investigating Korean speakers of L2 English and their voicing contrasts' development found evidence of positive transfer of voicing contrasts of voiceless English obstruents in word-initial and -final positions, and voiced obstruents in word-medial position. Negative transfer was evident in voiced obstruents in word-final position but not with voiced obstruents in word-initial position or voiceless obstruents in medial position.

Hansen (2001) in a study conducted with Mandarin Chinese users of L2 English indicated that the participants had less difficulty producing final clusters with nasals compared to final clusters with liquids. The author concludes that this was due to the fact that the L1 allows nasals but not liquids in coda position emphasising on the importance of L1 transfer.

The impact of L1 is also acknowledged by several models such as the Markedness Differential Hypothesis (MDH, Eckman 1991, 1985, 1977), the Ontogeny Model (OM, Major 1986, 1987a) and later the Ontogeny Phylogeny Model (OPM, Major 2001), and Optimality Theory (OT, Lombardi 2003, Broselow, Chen & Wang 1998). The MDH (Eckman 1977) recognises the L1-L2 differences for predicting learning difficulties despite the influence of markedness (section 1.3.4). The OPM and OM (Major 2001, 1987a – sections 1.4-1.4.2) suggest that L1 transfer has a strong effect during the early stages of L2 acquisition while its influence decreases as the L2 users become more proficient and the influence of developmental factors increases. Nonetheless, despite the three stages suggested, L2 users may not reach the second or third stage due to L1 transfer. OT (Lombardi 2003, Broselow, Chen & Wang 1998) also takes L1 transfer into consideration since the ranking of constraints in L2 acquisition depends on L1 rankings. Lombardi (2003) suggests that L1 is the source of differences in a study conducted with speakers of different L1 backgrounds acquiring L2 English. Specifically, L2 users were found to replace /θ/ in L2 English, which is absent in the L1. Nonetheless, the output sounds of L2 users differed with Thai, Russian, and Hungarian L1 speakers replacing the L2 sound with /t/ and Japanese, German, and Egyptian Arabic L1 speakers substituting the L2 sound with /s/. According to Ioup and Weinberger (1987), different output should be interpreted as L1 transfer since substitution patterns are consistent in any language. In the context of OT, these different outputs were due to the different constraints of the L1 in question with the one group demonstrating a 'more explicit transfer effect' and the other a 'universal ranking' (Lombardi 2003: 246).

However, despite the importance of L1 transfer on second language phonology, other factors such as linguistic constraints, markedness, linguistic environment, and the critical period hypothesis seem to be influential as well.

1.3.4. Markedness

L1 transfer seems to be a major process influencing second language phonology, however, it cannot account for all difficulties in pronouncing L2 sounds. Eckman's Markedness Differential Hypothesis (MDH) (1977) predicts that L1 transfer combines with markedness to shape second language phonology. Markedness constitutes a type of language universal since some linguistic features can be less universally marked (or unmarked). Specifically, the term 'markedness' refers to 'the tendency for certain linguistic elements to be more frequent in the world's languages, based on issues such as naturalness, salience, and ease of articulation in terms of phonological features' (Hansen 2009: 15). As a result, MDH was proposed as an alternative to CA aiming at improving some problematic aspects of CA. Specifically, just like CA, MDH aimed at comparing descriptions of L1 and L2 to predict areas of difficulty. Further, it incorporated a notion of 'relative degree of difficulty' (typological marked) that was universal and 'valid on grounds which are independent of the facts surrounding L2 acquisition' (Eckman 1977: 60). Thus, the construct of markedness was first used by Eckman (1977) with the MDH but it was then incorporated by Eckman, Moravcsik, and Wirth's Structural Conformity Fossilation Hypothesis (1989), and Han's Selective Fossilation Hypothesis (2009). In all studies, though, markedness aimed to predict and explain the difficulties of L2 users.

L2 research in an effort to investigate the influence of markedness focused on several areas such as preference for a universal syllable structure, length of margin, type of margin, length and type of margin, and the sonority hierarchy within a margin (Hansen 2009). Concerning syllable structure, CV syllables are considered to be unmarked compared to other syllable structures (Spencer 1996, James 1988). With reference to length, L2 users also tend to produce longer and, thus, marked structures to shorter, less marked structures. Longer onsets and codas, as a result, are reduced contrary to shorter structures (Anderson 1987, Eckman 1987, Major 1987b, Weinberger 1987, Sato 1984). Type of margin refers to manner of articulation and whether the members of a cluster belong to the same category (*i.e.* plosive-plosive) that results in a marked structure or to a different category (i.*e.* plosive-fricative) that results in less marked structures. Consequently, if a cluster allows two consonants from a similar category as plosive-plosive (*e.g.* kept), it can also allow fricative-plosive (*e.g.* fast), and plosive-fricative (*e.g.* hats) (Hansen 2009). Markedness defined by length and type of margin refers to three- or two- member clusters that are thought to be more marked structures. Research indicates that more marked structures are acquired after the corresponding unmarked structures had been acquired (Carlisle 1998, Eckman 1991). Finally, markedness defined by sonority refers to the sonority hierarchy within an onset or coda. Sonority, 'the loudness and/or resonance of a given segment in relation to other segments' (Hansen 2009: 18), implies that clusters closer in sonority are more marked than clusters consisting of consonants that have a wider sonority distance. The sonority hierarchy moving from the most to the least sonorous involves low vowels, high vowels, approximants, nasals, voiced fricatives, voiceless fricatives, voiced plosives, and voiceless plosives (Carr 1999).

MDH (Eckman 1996, 1981, 1977) states that the L2 areas that are different from L1 and are more marked (less universal) are more difficult to acquire. The L2 areas, though, that are distinct from L1 but are unmarked (more universal) will not be difficult. Eckman uses as an example the voicing contrast of obstruents. Specifically, he supports that the existence of voiced obstruents in a language (*i.e.* English) also implies the existence of voiceless obstruents, but not the reverse (*i.e.* Korean). Based on MDH, as a result, voiced obstruents are more marked than their voiceless counterparts.

In a study on German-English obstruents, Dinnsen and Eckman (1975) proposed a universal hierarchy for voicing contrast. Specifically, if a voicing contrast exists word-finally in a language, this implies a contrast medially that implies a contrast initially in turn. Nonetheless, the reverse does not occur (Figure 1). In the languages under investigation the voicing contrast in word-final position exists only in English whereas in German it does not. Consequently, as MDH predicts, a German speaker of L2 English will encounter a great difficulty with English word-final contrasts than an English speaker of L2 German since this contrast is absent in the latter.

Initially	Least marked
|	|
Medially	|
|	|
Finally	Most marked

Figure 1: Voice Contrast Hierarchy

A second example is provided with the distinction of /ʒ/ in French and English. Whereas French has a /ʃ/-/ʒ/ contrast word-initially, -medially, -finally, English lacks this contrast in word-initial positions. Nonetheless, the English speaker of L2 French will not have difficulties learning the contrast in initial position since it is not more marked than a voice contrast in the other positions.

Anderson (1987) tested Eckman's MDH in an L2 syllabification study involving L1 speakers of Egyptian Arabic and Chinese. The hypothesis was that the former group would perform much better than the latter since the structure of the syllable in Egyptian Arabic is closer to the syllable structure of English. In fact, the Arabic group did much better while it was also indicated that MDH predicted the relative difficulty of most cluster types examined for each group since the hierarchy of errors was the same for both groups. Both initial and shorter clusters were easier to learn compared to final and longer clusters respectively. The reason was that the former were considered unmarked while the latter were thought as more marked since they do not occur that often across languages.

MDH, thus, seems to be a direct response to CA criticisms of not being able to predict the most difficult areas in L2 phonology for a specific language group as well as the exact sounds that would be substituted by the L2 user. Eckman (1977) suggests that CA should not be abandoned but 'revised to incorporate a notion of degree of difficulty which corresponds to the notion of typological markedness' (68). Even though CA was disfavoured in the 1970s, 'in the 1980s and continuing in the 1990s there has been a resurgence of interest in transfer with the admission that even though universals are important, transfer exerts a very strong influence in SLA' (Major 2001: 35) and probably is a permanent component of second language phonology. Various studies on phonology stress the importance of transfer on segments (Zampini 1996, Hancin-Bhatt 1994), syllable structure (Eckman & Iverson 1994, Flores & Rodrigues 1994, Broselow 1984), metrical structure (Archibald 1992), rhythm (Wenk 1986), general phonological phenomena (Singh & Ford 1985), and loan phonology (Yip 1996, Van Coetsem 1988). The moderate version of the CA is more generally accepted suggesting that similar phenomena are more difficult to be learned than dissimilar phenomena, compared to the strong and weak forms of CA[6]. The psycholinguistic reason why similar sounds are more challenging for L2 users implies that minimal differences may not even be noticed leading to non-learning while 'gross differences are more often noticed, due to perceptual saliency' (Major 2001: 37) and can, thus, lead to learning[7]. Nowadays, the reason is because the original claims of CA are too strong since there are also other factors determining the difficulties of L2 users when acquiring new sounds (Major 2001, Flege 1995, Odlin 1989, Eckman 1977).

1.3.5. Sensitivity to Phonological and Morphological Environments

An area that has not received much attention in L2 is sensitivity to particular phonological or morphological environments that results from L1 bias and/or prominent aspects of L2 grammar. The research that has been conducted, though, suggests that particular phonological environments influence the production of consonants and consonant clusters and may interact with factors such as L1 transfer (Hansen 2009). Benson (1988) examining the

[6] The strong version of the CA suggests that contrastive analysis of the L1 and L2 can predict error, difficulty, and success while the weak version argues that contrasting the L1 and L2 can facilitate an analysis of the sources of the errors of the users.

[7] According to Major (2001), learning is not equal to nativelike attainment but to 'a stage beyond straight transfer'. (37).

production of English syllable structures by Vietnamese users proposed that the preceding vocalic context was a factor of L1 transfer. In this study, single consonants were deleted after diphthongs since in Vietnamese diphthongs are allowed in CV structures. Weinberger's study (1987) put forward that English consonants and consonant clusters were modified by Mandarin users when occurring between consonants. Anderson's findings (1987) indicated that the American English /ɹ/ was deleted post-vocalic in final clusters and word-medial sequences by Mandarin users, while /t/ and /d/ were deleted in word-final position in consonant clusters. Carlisle (1997) found that epenthesis was taking place after consonantal than vocalic environment, which is in line with Edge's findings (1991). In the latter study, non-native and native speakers' production of final obstruents was compared indicating that vowel epenthesis was taking place after a consonant and particularly after word-final voiced plosives. Carlisle (1994) re-examining Tarone's data (1987) suggested that epenthesis after word-final consonants was more frequent to occur before a pause while it was less likely to occur before a word-initial vowel. Bayley (1996) proposed that –t/d was rarely deleted when following a liquid compared to a nasal or obstruent.

Grammatical conditioning may influence syllable coda production as well. Saunders (1987) indicated that /s/ was more likely to be deleted in the third-person singular than in plural in final /ps ts ks/ clusters that is line with Abrahamsson (2001). Osburne (1996) suggested that a grammatical marker was rarely deleted in CC and CCC codas even if the coda was not following the syllable structure rules.

These findings indicate that sensitivity to particular phonological and morphological environments is probably due to L1 transfer effects rather than universal preferences (Osburne 1996, Benson 1988, Sato 1985) and can account for the reason why some consonants and consonant clusters are modified and how they are modified (Hansen 2009).

1.3.6. Critical Period Hypothesis

For language acquisition, a critical period has been hypothesised (Critical Period Hypothesis, CPH) suggesting that nativelike ultimate attainment is not possible after a certain age due to maturational constraints. These constraints were originally thought to affect the acquisition of L2 phonology (Scovel 2000, 1988, Lenneberg 1967) suggesting that beyond puberty (around age 13) nativelike attainment could not be acquired. More recent research, however, argues that other linguistic abilities may also be influenced including morphology, syntax, and the lexicon (Hyltenstam & Abrahamsson 2003, DeKeyser 2000, Hyltenstam 1992, Long 1990, Seliger 1978). Specifically, in terms of phonology, complex phonological rules in an L2 seem to be acquired in a nativelike manner until age 6 (Flege Munro & McKay 1995, Chambers 1992, Sibata 1990, 1958, Payne 1980, Oyama 1978, 1976) while simple rules and pitch-accent features until age 13. For L2 lexis and collocation, nativelike attainment is achieved until age 6 (Lee 1998, Spadaro 1996, Hyltenstam 1988) while for morphology and syntax until age 6 or even younger (Mayberry 1993, Newport 1993). For L2 acquisition of morphology and syntax the critical age seems to involve the midteens (DeKeyser, Ravid & Alfi-Shabtay 2004, DeKeyser 2000, Hyltenstam 1992, Johnson 1992, Johnson & Newport 1991, 1989, Patkowski 1982, 1980).

More research on the effects of CPH has also led to the formulations of two basic versions of a Sensitive Period Hypothesis (SPH)[8]. The Exercise Hypothesis (EH) and Maturational State Hypothesis (MSH) make similar predictions for L1 acquisition but differ in terms of predictions regarding L2 adult acquisition. Specifically, the EH supports that 'once used, or exercised, within the genetically determined period, the language acquisition capacity is available, undiminished, for life' (Long 2007: 47). As a result, adults who acquire an L1 will do poorly and not as well as children but if they acquire the L1 within the determined period will do as well with L2 as children. However, EH cannot account why adults do poorly compared to L2 children. MSH on the other hand, suggests that 'the genetically inherited, language acquisition capacity operates only within a genetically determined period and no later, whether or not exercise during that period' (Long 2007: 48). Consequently, adults acquiring an L1 or an L2 will do poorly compared to children acquiring an L1 or an L2. EH, thus, seems to be displaced by variants of the MSH that involve the number and timing of sensitive periods positioned.

As a result, research on different linguistic abilities and the sensitive periods in L2 for acquiring nativelike attainment in these abilities seems to support the existence of maturational constraints on language acquisition. Nonetheless, counterevidence to a SPH in L2 suggests that L2 nativelike attainment is not affected by maturational constraints. Specifically, it is suggested that nativelike attainment is influenced by other learner and/or environmental

[8] 'Sensitive period' is a term that may sometimes be used instead of 'critical period' due to more recent results suggesting that the former is more appropriate when discussing the human language learning capacity (Oyama 1979). However, a 'sensitive period' is different from a 'critical period' since the latter is determined by neurobiological maturation while a 'sensitive period' is determined by cognitive maturation (Schmid 2009).

factors, that there is a conflict between patterns in the data from age difference studies and one or more hypothesised sensitive period(s) for L2 (DeKeyser & Larson-Hall 2005, Stevens 2004, 1999, Hakuta, Bialystok & Wiley 2003, Hyltenstam & Abrahamsson 2003, Jia & Aaronson 2003, Jia, Aaronson & Wu 2002, Bialystok 2002, Birdson & Molis 2001, Bialystok & Hakuta 1999, Bialystok & Miller 1999, Long 1990, Newport 1990, Johnson & Newport 1989), and that there are late learners able to achieve nativelike attainment in L2 (Neufeld 2001, 1978, 1977, Bongaerts, Mennen & van der Slik 2000, Bongaerts 1999, Bongaerts, Van Summeren, Planken & Schils 1997, Palmen, Bongaerts & Schils 1997, Bongaerts, Planken & Schils 1995). The above challenges, though, are not clear whether they are sustainable. Despite the disagreement that exists on the maturational constraints explanation, though, both supporters and opponents of the idea seem to agree that older children and adults can rarely achieve high levels of proficiency in the L2 contrary to young children. Therefore, there are 'clear differences in eventual levels of success related to the age at which learning begins' (Long 2007: 59).

In an effort to explain sensitive periods, several reasons have been provided. The first one involves language-specific human biology. Specifically, language acquisition for children seems to be at a similar rate and near uniform levels of nativelike attainment despite the variation in complexity of the languages being acquired involving typological differences and features such as richness of morphology and regularity of grammar rules. Nonetheless, the situation differs for adults. Specifically, even adults of the same L1 may be presented with different learning tasks in these languages. This was indicated in a study conducted by Odlin (1989) in which L1 English adults were found to require twice the number of instruction hours to achieve the same proficiency level in Arabic, Chinese, Turkish, or Russian as for French, Spanish, or German. Variation in children's general intellectual abilities and linguistic environments had relatively little effect. Second, in normal acquisitional settings, children can acquire a language at a normal rate as cases of isolated or abused children and hearing children of nonsigning deaf adults indicate. In these cases, the children were able to catch up with the rest of the children and proceed at a normal rate (Long 1990). Third, after a certain stage nativelike attainment is not feasible. The case of Genie (Curtiss 1977) who was 13,7 when discovered and deaf individuals who were exposed to a sign language during adulthood (Newport 1990) are such examples while the recovery from trauma-induced aphasia is said to worsen after the early years.

The benefit of an early start seems to continue 'after the closure of the hypothesized sensitive periods' (Long 2007: 73). Mayberry and Lock (2003) stress the benefit of an early start in a study examining the L2 syntactic abilities of deaf adults who acquired a spoken or signed language during childhood and deaf adults who did not. The results indicate that the abilities of the first group were near-native compared to the second group.

As a result, the catch-up phenomenon and the early start benefit imply that the exposure to one or more language, except the L1, is neurophysiological. This neurophysiological change is evident during the L1 acquisition and continues into the early teens for some complex syntax. The reason is that 'early richer linguistic exposure leads to the creation of more, and more complex, neural networks before synaptic sheaths harden as part of the mylenization process, making new ones for new languages more difficult to create in older starters' (Long 2007: 74). An indication of this can be the more complex dendritic bundles of L2 users compared to L1 users (Jacobs 1988) even though the difference is not clear that is age dependent. This neurophysiological explanation is responsible for the nativelike attainment of children compared to older children and adults after the maturational constraints take effect.

1.4. The Ontogeny Model

Second language phonology seems, thus, to be susceptible to a number of factors. In an effort to provide an explicit theory about the interrelationship of the abovementioned factors, Major (1987a) proposed a model of L2 phonological acquisition suggesting that L2 users' phonology changes over time and varies with style (development of Stampe's ideas). Based on this model, transfer processes are evident at the early stages of acquisition but decrease over time, while developmental processes are infrequent at the early stages and increase only later but then they decrease over time (Figure 2). Developmental processes do not appear at the early acquisitional stages because they are prevented by the transfer processes. Therefore, it is only later, when transfer is eliminated, that developmental processes can operate.

Figure 2: Relationship of transfer and developmental processes to time

The influence of transfer in learning is supported by considerable evidence (Ausubel, Novak & Hanesian 1978, Gagné 1977, Travers 1977, Ausubel & Robinnson 1969, Ausubel 1967, 1963, Schultz 1960). In SLA, therefore, a beginner will transfer L1 patterns into L2 but as a result of learning the second language phonology system, these will be modified by L2 experience leading to new cognitive structures that will further influence second language phonology modifications. Following this, L1 transfer will decrease, while developmental processes will first increase and then decrease. In other words, at the beginning stages of L2 acquisition, the language user can only depend on the L1 while the developmental processes (universals) that are evident are the ones that are part of the L1. Consequently, at these stages, developmental processes remain 'dormant' (Major 2001). However, at a later stage of the L2 acquisition, developmental processes start to influence resulting in phenomena that are not either part of the L1 or the L2. Finally, as the L2 develops, developmental processes decrease since 'after a U[niversal] principle has operated and has been "correctly" instantiated [..] (i.e., it is nativelike), U has "done its work" so to speak and therefore does not appear as a nonnative part' (Major 2001: 87) but rather as part of the L2 component. When the language user reaches this stage, the L2 is mastered.

'In L2 phonology, learners' substitutions typically take the form of phoneme substitutions (e.g., [R] for [r]), phonological processes (e.g., devoicing), phonotactic modifications (e.g., consonant cluster simplification or schwa epenthesis), and prosodic alternations (e.g., using syllable-timing for a stress-timed language)' (Major 1987a: 104). L2 users can master phenomena that they are consciously aware such as phoneme substitution than phonological processes since the latter are usually unconscious. Major (1987a) suggests that the acquisition of L1 children and L2 adults are similar in terms of the mechanism of substitution. What differs is merely the learner's starting point with L1 children depending on the native pre-language system or an L1 at a specific point in time while L2 adults depend on an L1 system and, thus, all substitutions are related to this system. As a result, acquisition in the child and adult are similar since both of them gradually approximate the target from their own starting point. Based on this model, predictions involving the acquisitional stages can be made for both L1 children and L2 adults due to universal considerations. Major uses as an example the acquisition of the English vowel /æ/ by an English L1 child and a Spanish L2 adult. Both speakers will substitute the vowel with [a] suggesting that their starting points (their L1 systems) are the same, namely a five vowel system. Progressive approximation to [æ] will be similar for both speakers as acquisition progresses *i.e.* [a] > [aˆ] > [æˇ] > [æ] (Major 1987a: 105).

The model also allows positive and partial transfer to take place. If a sound or process exists in both the L1 and L2, then this can be transferred to L2 without any intermediate stages (positive transfer). Also, if the L1 and L2 have a common phenomenon, which however does not operate in all L1 environments as in L2, the user can learn it easier than if it did not exist in L1 (partial transfer). A further issue involves the processes of transfer and development. These may be the same in certain cases leading to the conclusion that there are three types of substitutions. Substitutions, thus, may refer to transfer, namely the processes that are present in L1 but not in L2 or L1 acquisition, developmental processes that take place in L1 acquisition but not in L1, and ambiguous processes occurring both in the adult L1 phonology and L1 acquisition.

The same relationship that exists between transfer and developmental factors over time is said to hold for stylistic shifts as well. Specifically, as style becomes more formal transfer decreases and developmental processes increase and then decrease (Figure 3) suggesting that these are factors building the second language phonology. 'Style shifting' occurs as the L2 users attempt to communicate orally in the L2 since their utterances may point to systematic variability in terms of the phonological, morphological, or syntactical forms related to the task (Tarone 1985). Several studies have indicated that second language phonology varies systematically with different testing situations (Dickerson & Dickerson 1977, Dickerson 1975, 1974). With reference to second language syntax, this variability may refer to significant differences across tasks, in the percentage of 'errors' occurring in various grammatical categories, and in the degree to which the processes of transfer and overgeneralisation occur (LoCoco 1976). According to Beebe (1980), '[second language] becomes more permeable to a superordinate rule system in formal situations' (386) in which the superordinate system can be either the L1 or the L2. Evidence for these stylistic shifts involves the minimal pairs that refer to pronunciation of isolated words. In most cases, in minimal pairs L2 users may produce sounds and words quite correctly (with better pronunciation), but this may not be achieved in connected speech that will be affected by L1. Transfer processes suppress in isolated words are evident in free speech where L2 users do not bother with form that much but emphasis is given to content. These processes in L2 speech are influenced by L1 processes and universal stylistic consideration such as fortition and lenition. The former (strengthening processes) is more evident in formal styles while the latter (weakening processes) in more casual speech (Lass 1984, Donegan & Stample 1979). A case of fortition is provided with Carlisle's study (1997) investigating the acquisition of L2 English sC onset clusters in a formal style (formal type of speech) by L1 Spanish speakers. The results indicated that Spanish speakers responded to /s/ by inserting a V before it since sC clusters are not an allowed onset in Spanish. Insertions are an example of fortition or strengthening process reinforcing segments or sequences. Abrahamsson (1999) aimed at confirming and expanding Carlisle's results (1997) to a conversational style. The results indicated that as L2 proficiency increases over time, errors begin to disappear as predicted by the model. Cardoso (2007) examining the acquisition of word-final plosives by adult L1 Brazilian Portuguese speakers of L2 English in a classroom context indicated that more proficient speakers in more formal stylistic environments tend to achieve L2 production.

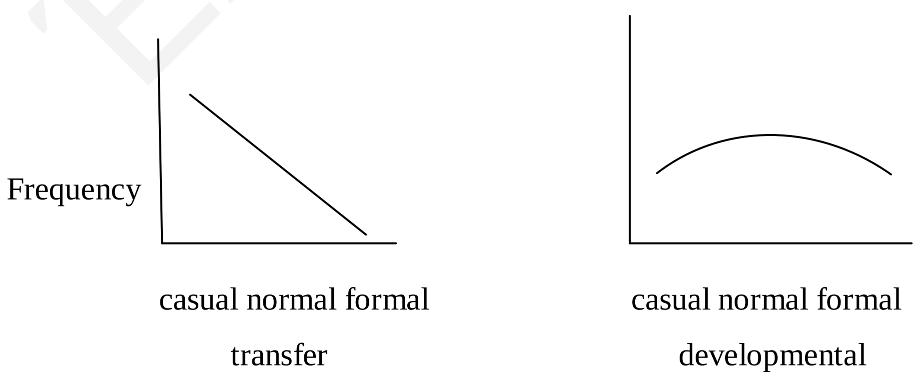

Figure 3: Relationship of transfer and developmental processes to style

Regarding the L2 users, many transfer processes may not become evident if the learners are very good mastering L2 sounds on first attempts (slight accent). In the case of poor learners, progress 'is very slow while fossilisation may occur'. This is because the predominance of transfer processes results in a heavy accent. In the case of moderate accent, some developmental processes are evident because some transfer processes have been overcome (Figure 4).

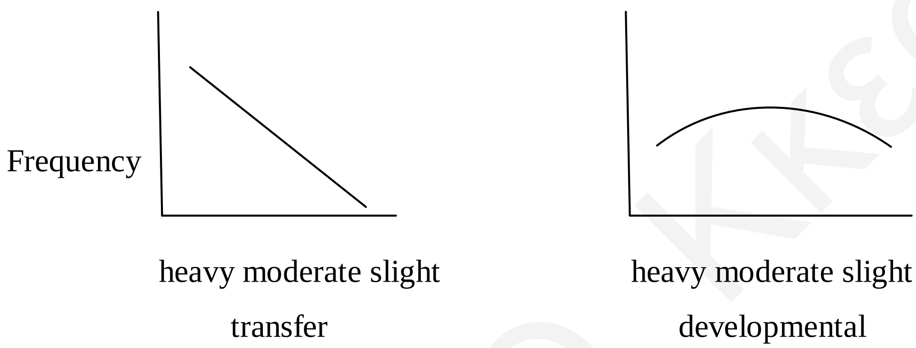

Figure 4: Degree of accent

A final point refers to the likehood of transfer when L1 and L2 have similar phenomena compared to phenomena that are very different from the L1. According to Brown (1980), '[t]he principle at work is common in human learning: interference can actually be greater when items to be learned are more similar to existing items than when items are entirely new and unrelated to existing items' (159). Based on the Ontogeny model, more transfer processes for similar phenomena are present and more developmental processes for phenomena that differ. L2 users unconsciously think of L2 phenomena to be identical with L1 phenomena that results in learning difficulties. On the contrary, L2 phenomena that are completely different in L1 are easier for L2 users since they are conscious about these. In this latter case, transfer processes are eliminated resulting in developmental substitutions or L2 pronunciation. This can be observed in the acquisition of the L2 English /æ/ by L1 Brazilian Portuguese speakers since in their L1 there is /ɛ/ but no /æ/. As a result, L2 users at the early stages of acquisition substitute [ɛ] for English [ɛ] and [æ]. L2 users at later stages master the [æ] but may still substitute the slightly lower Portuguese [ɛˇ] for English [ɛ]. This happens since L2 users quickly understand that Portuguese has not [æ] but not of the fact that the [ɛ] in the L1 and L2 are different. Another reason may be the fact that there is a greater distance between the Portuguese [ɛ] and the English [æ] than between the Portuguese [ɛ] and the English [ɛ]. Because the difference is slight, the L2 user may not notice it at all.

The above principle, though, is not applied for foreign accent. More specifically, a heavy accent is expected when the L1 and L2 are quite different. The reason is because there is more to be mastered than if the two languages are similar. Substitutions are perceived as foreign accent regardless of whether they are due to transfer or developmental processes. For instance, the production of liquids in the L2 English by a Korean speaker may be thought as nonnative to a native English speaker even if the L2 user is using substitutions that exist neither in the L1 or the L2. On the contrary, the speech of a Portuguese L2 user of English may be thought as a slight accent in spite of using an unrounded [š] and a very fortis [v] in his speech, which characterise the L1. However, since a rounded [š] exist in the English language, the accent of the Portuguese L2 user is not as detectable as the accent of the Korean L2 user, even if it is the Korean L2 user who has moved beyond L1 transfer.

1.4.1. Studies on the Ontogeny Model

The OM of phonological acquisition proposed by Major (1987a) suggests that the influence of both transfer and developmental factors affect the acquisition of a new language sound system and must be taken into account in attempts to explain L2 difficulties that previous theories failed. OM constitutes a similar proposal made by Tarone (1983, 1982, 1979) with the Chameleon model. Tarone (1983, 1982, 1979) proposed the Chameleon model to account for second language since according to the researcher the second language system changes when a linguistic environment changes (chameleon-like nature). The model has five axioms: style-shifting across social situations and topics, attention to speech, vernacular, formality, and good data (Tarone 1983, 1982, 1979) and suggests that the amount of attention paid directly to speech by L2 users causes variation in L2 pronunciation during tasks of differing formality levels. The model tries to account for this variation implying that each type of task fits into a style continuum in which careless speech (least formal style) constitutes the one edge of the continuum while careful speech (most formal style) the other edge of the continuum. Careless speech contains the lowest number of accurate L2 forms while careful speech contains the highest while between the two edges there are many intermediate styles. Accuracy seems to increase as the language user moves toward more careful speech styles. Major's OM also suggests that L2 pronunciation changes over time or according to speech formality.

Several L2 studies seem to support the Chameleon model and the OM. Dickerson and Dickerson (1977), examined the pronunciation of L2 /r/ by Japanese L1 speakers of L2 English who were found to produce a list of words (more formal task) more carefully than reading a dialogue or participating in a conversation (less formal task). According to the Chameleon model, more errors occurred in the free speech task (conversation) while fewer errors appeared in the word list task. With reference to the OM, the results suggest that in the word list task both transfer and developmental factors were eliminated but in the conversational task both processes were involved.

Major (1987a) in a pilot study examining various aspects of L2 English pronunciation by L1 Brazilian Portuguese speakers indicated that L1 transfer has taken place. The L2 users were divided into two groups reflecting their different stages of L2 acquisition (beginners vs. advanced) and were tested for [i] insertion both word-finally and in word final consonant clusters in four tasks of differing formality. Since Portuguese does not allow word-final consonant clusters or single consonant other than /s/, Major concluded that [i] insertion was due to L1. These errors seemed to decrease as speech became more formal while advanced learners demonstrated fewer instances of transfer compared to beginners. The latter group demonstrated either greater or lesser occurrence of developmental processes than the advanced group that is in line with the model since developmental processes are first increasing and then decreasing. However, Major emphasised the need for more research regarding the OM and the fact that the model may not always predict the correct results concerning stylistic variation rules from L1.

Wode (1981) by studying his own four children between the ages 3;4-7;6 describes their developmental sequences for approximately three years. The children were German-speaking trying to acquire L2 English. The two developmental sequences suggested involved gradual approximation as in the acquisition of vowels and discrete jumps as in the acquisition of the consonant /r/. Based on the model, the early substitutions are because of transfer that then gives way to developmental processes and eventually are replaced by L2 processes. Flege (1980) studied Saudi Arabic speakers learning English. The acoustic analysis indicated that regardless of early transfer, the participants gradually approximated the voice onset times (VOT) for English plosives that were intermediate between Arabic and English sounds. Moreover, more experienced Saudis' production was closer to native English.

Concerning style, Wode's study (1981) also provided evidence for the decrease of transfer processes as style becomes more formal. Specifically, transfer was most evident when the style was the most casual and the least prominent when the style was the most formal. Consequently, Wode's daughter was using more L1 substitutions in her 'casual spontaneous speech', but in her imitations-like check ups, she was trying to use the L2 sound or something like the L2 sound. Because achieving the targetlike sound was difficult, her attempts were characterised as U substitutions (developmental processes). 'Logically then, in the idealized or extreme case, if a very formal style is pure L2 and very casual style is pure L1, then as style changes from formal to casual the U component has to appear and then disappear; that is, it increases and then decreases' (Major 2001: 96).

Both the Chameleon and OM were challenged by Beebe (1987) in a study of Thai speakers of L2 English. This study concentrated on the pronunciation of English /r/ in a word-initial and -final position in an interview (less formal style) and the reading of a word list (more formal style). The results for the pronunciation of /r/ in the word-final position indicated that fewer errors occurred in the word list that is in line with the two models. Nonetheless, for the word-initial /r/, more errors also appeared during the word list. Beebe attributed this to the fact that in Thai there is a prestigious variant of /r/ used for more formal speech. Thai speakers transferred this L1 notion that resulted in more errors during the word list task compared to the interview task.

1.4.2. The Ontogeny Phylogeny Model

An updated version of the OM (Major 1987a) has been offered by Major's Ontogeny Phylogeny Model[9] (OPM, Major 2001) in an effort to explain the process of acquiring an L2 sound system. Major (2001) suggests that universals, markedness, and transfer are factors that influence language acquisition and combines these into one model. The OPM (Figure 5) is based on the premise that developing second language phonology consist of 'parts of L1+parts

[9] According to Major (2001), Ontogeny 'when referring to language, deals with language development in an individual person over a period of time that can span a few moments up to a life time' (136) while Phylogeny refers to 'language development and change in populations over part of a generation or over many generations as well as changes in whole languages and language families' (136).

of L2+parts of Language Universals, which are not already part of L1 and L2' (Major 2001: 81). This model maintains that second language phonology develops chronologically (Chronological corollary of the OPM) with features of L2 increasing, L1 patterns decreasing, and universals (developmental phenomena) increasing and then decreasing in the course of L2 development. Second language is also thought to vary stylistically (Stylistic Corollary of the OPM) with L2 structures increasing in more formal styles, L1 features decreasing, and universals increasing and then decreasing. That may explain why L2 users are more careful with isolated words (formal style) than with complete sentences (casual style) (Major 2001). The model also makes a claim about similarity (Similarity Corollary of the OPM) suggesting that '[i]n similar phenomena, [it] develops chronologically in the following manner: (a) L2 increases slowly, (b) L1 decreases slowly, and (c) U increases slowly and then decreases slowly' (Major 2001: 85). In other words, the L1 has a more important role compared to universals in similar phenomena while for less-similar phenomena, universals are more influential than the L1. This is because minimal differences are not easily noticed when it comes to similar phenomena resulting in non-learning, that is, transfer takes place (Major 2008, 2001). This implies that L2 users will have more difficulties acquiring sounds that are phonologically similar than sounds that are dissimilar due to minimal differences. Lastly, concerning markedness, the model does not proceed to any claims but merely suggests that the marked phenomena are acquired later than the unmarked phenomena (Markedness Corollary of the OPM). Specifically, '[i]n marked phenomena, [it] develops chronologically in the following manner: (a) L2 increases slowly, (b) L1 decreases and decreases slowly, and (c) U increases rapidly and then decreases slowly' (Major 2001: 85). As a result, the role of universals is greater than that of L1 for marked phenomena, except for the earliest stages where the L1 is the most likely substitution for both marked and unmarked phenomena. As the L2 develops, the language user attempts to use something other than the L1 resulting in universal substitutions rather than nativelike L2. Since the L2 is achieved slowly, this means that universals decrease slowly.

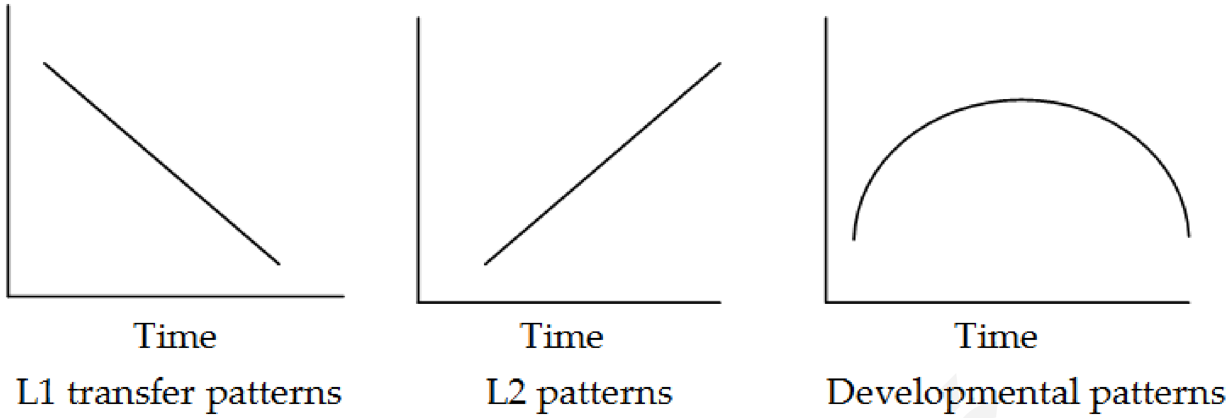

Figure 5: The Ontogeny Phylogeny Model (Major 2001)

Nonetheless, despite the fact that the OPM makes clear empirical predictions, no scientific research hypotheses that have resulted from it have been tested empirically.

1.5. Causes of second language phonology fossilisation

Fossilisation of L2 pronunciation constitutes a main concern in second language phonology study. This concern can be expressed in two central questions involving the inevitability of fossilisation in adult L2 users and the causes for this phenomenon.

According to Scovel (1969), adults tend to retain a non-native L2 pronunciation even if they can achieve nativelike fluency in areas such as syntax. An example of this was Joseph Conrad (*henceforth* 'Joseph Conrad phenomenon') who had a characteristic Polish accent despite his nativelike fluency in other areas of his L2 English. Nonetheless, Hill (1970) suggests that this kind of fossilisation is not necessarily inevitable, being the result of social and cultural factors in Western culture. According to Hill (1970), native peoples such as the Vaupés Indians of the Amazon and the Siane of New Guinea can obtain nativelike fluency in several L2s acquired during adulthood. Moreover, Neufeld (1977) supports that there are methods of teaching L2 pronunciation that can lead to native- or near-native proficiency for adults.

With reference to the causes of fossilisation of pronunciation, these can be traced to physiological causes. One such explanation implies that nativelike pronunciation cannot be achieved since the muscles and nerves of the tongue and mouth needed for pronouncing new L2 sound patterns have atrophied since they have been practising the same set of pronunciation habits for years. However, no research evidence has been provided to justify this atrophy. Scovel (1969) supports the notion of 'lateralisation' based on Lenneberg (1967), in which the brain is no longer capable to learn a new language after a certain age (CPH) that influences L2 pronunciation more than other areas of language. This notion is opposed, though, by Krashen (1973), who after reanalysing Lenneberg's data and dichotic listening data, indicated that lateralisation occurs at about the age of five.

Psychological causes have also been proposed for the fossilisation of pronunciation. Based on Krashen (1977) and Rosansky (1975), the close of the critical period is connected to the onset of Piaget's stage of formal operations. Adolescents at this stage of cognitive development abstract rules about pronunciation and grammar and apply them consciously (learn L2) rather than unconsciously which is what happens with L1 children (acquire L1). This account, however, does not explain the 'Joseph Conrad phenomenon'. A second psychological cause is the psychological habit formation that is said to be related with the L1 transfer issue. This claim, which is not supported by a comparative study, suggests that 'it is psychological habit formation and negative transfer that for some reason selectively operate to make [second language] phonology singularly resistant to change' (Tarone 1978: 84). Neufeld's experiment (1977) testing a new technique for teaching L2 pronunciation to adults is based on a psychological habit formation hypothesis. In this experiment, 20 English-speaking adult students were instructed in three non-Indo-European languages, namely Chinese, Japanese, and Eskimo. The students were asked to watch 18 videotaped lessons that involved 100 stock phrases in the abovementioned languages. Then the emphasis was on intonational contours of the phrases. Only later the participants were permitted to repeat whispering what they could hear while it was not until the last three lessons that they could normally repeat the phrases. Afterward they recorded these phrases and native speakers of the languages in question had to decide whether the speakers were native or not. Almost half of the participants were judged as native or near-native speakers of the languages. It is the researchers' contention, thus, that adults form incorrect acoustic images of the L2 sound patterns because they are exposed to inappropriate learning situations/input. This leads to the L2 users' pronunciation patterns.

The last kind of causes proposed for the fossilisation of pronunciation involves affective factors. Labov (1972) indicated that pronunciation patterns change when a speaker wants to be a part of a specific social group allowing easier inclusion in the particular group.

Guiora et al. (1972) in an effort to increase the empathy levels of L2 users administered amounts of alcohol to the participants. The findings pointed that the participants' L2 pronunciation improved up to a specific point while when greater amounts of alcohol were consumed, this quickly worsened. The researchers concluded that second language pronunciation is a more sensitive indicator of empathy when compared to other language areas. Adults have established their cultural identity by the time they started learning a L2 and their accent to communicate their identity. This finding is in line with Hill (1970) whose native tribes can easily learn an L2 including pronunciation since their cultures value multiligualism. Guiora et al.'s results can also be explained by the fact that the alcohol led to muscle relaxation enabling participants to achieve better L2 pronunciation. Peck (1977) working with children, though, pointed out that children mock the accents of L2 children directly and frequently. This may lead children to acquire a nativelike pronunciation but the same does not occur with adults.

The abovementioned account provides a close insight into the possible causes of fossilisation of pronunciation. Physiological, psychological, and affective factors seem to be all active leading to fossilisation of pronunciation. Nonetheless, as already noted there is not enough research evidence for physiological factors, while psychological factors like the formal operations argument and psychological habit formation argument seem to be limited in important ways. On the contrary, affective factors involving empathy and cultural identity provide appealing teaching implications.

2. Speech Perception

2.1. Investigating Speech Perception

Speech perception refers to the mapping of speech acoustic signals (sound waves) onto linguistic information. This mapping, though, is not straightforward since it involves the mapping between the properties of the acoustic signal and different linguistic elements such as phonemes, distinctive features, syllables, words, and phrases. Nonetheless, listeners can almost effortlessly identify the speech sounds (phonemes), recognise the words they make up (lexicon), and understand the message they produce (semantics) by the sentences they form (syntax).

Research in speech perception has mostly concentrated on the description of the acoustic signal of speech and specifically on three problems that arise, that is, the problems of linearity, invariance, and coarticulation. With reference to the first problem, the acoustic information is 'time-bound, transient, and solely under the speaker's control' (Mattys 2011: 2). What is more, the acoustic signal is conveyed linearly, that is, one bit of information at a time that results in the information's spreading over time. Taking this into account, meaning can be extracted within a 'window of time' that goes beyond the amount of information that can be retained in echoic memory (Nooteboom 1979, Huggins 1975) while speech perception and lexical-sentential integration must take place sequentially in real time. Listeners can cope with these difficulties and successfully recognise many words in sentences before their offsets (Marslen-Wilson 1984). Short and phonetically reduced words, though, may be identified later on (Bard, Shillcock & Altmann 1988). Research in fast speech, which permits more information to be conveyed in the same amount of time, indicated that there are no effects of speech rate on phonemes' perception in monosyllabic versus disyllabic words. Other studies, however, found such effects (Radeau et al. 2000, Pitt & Samuel 1995) but these involved time expansion experiments. Overall, the problem of linearity implies that echoic and short-term memory mechanisms must be considered in speech processing as well as the lack of boundaries between phonemes and between words.

A second problem involves the lack of acoustic invariance of a speech sound and its acoustic manifestation. Specifically, it seems to be a many-to-one mapping between representations and speech sounds instead of a speech sound having only one representation. With reference to word level, this many-to-one mapping can be overcome by defining a set of core features for each word stored in memory and reducing the mapping procedures to only those features (Mattys 2011). Phonemes, however, constitute more complicated cases since they can vary considerably in their acoustic manifestation even within the same speaker. This may be attributed to speech rate, voice quality, and accent and it involves both the word and phoneme levels. As a result, it seems difficult to map phonemes or phonetic categories onto specific acoustic cues or invariants. Nonetheless, plosive consonants seem to provide an example of such mapping. Distinguishing between voiced and voiceless plosives (/b, d, g/ vs. /p, t, k/) seems to depend on the duration between the release of the consonant and the moment when the vocal folds start vibrating.

Voice onset time (VOT) (Lisker & Abramson 1970) is a robust cue for the voicing distinction. In English, the VOT of voiced plosives is around 0ms (or at least shorter than 25ms) while for voiceless plosives is over 25ms. Specifically, VOT is considerably longer for voiceless plosives than voiced ones yielding approximate mean values of 58ms for [p] versus 1ms for [b], 70ms for [t] versus 5ms for [d], and 80ms for [k] versus 21ms for [g] (Lisker & Abramson 1964). In CG, that is a variety in which voiced plosives are thought to be absent (Arvaniti 2010) or realised differently (Okalidou et al. 2010, Botinis et al. 2004), the VOT of plosives is considerably longer for voiceless aspirated plosives compared to voiceless unaspirated ones with mean values of 55ms for [p^h] versus 5ms for [p], 60ms for [t^h] versus 17ms for [t], and 65ms for [k^h] versus 22ms for [k] (Tserdanelis & Arvaniti 2001, Arvaniti 1999). This suggests that CG voiceless plosives differ from the English ones while CG voiceless aspirated plosives are the ones that are closer to the English voiceless ones.

Coarticulation constitutes the third problem referring to the effect of the articulation of one phoneme on that of another phoneme. This blending of articulatory gestures between adjacent phonemes is evident both within and across words even though the degree of coarticulation between phonemes is somewhat less pronounced across than within words (Fougeron & Keating 1997). This lack of phoneme and word boundaries, though, does not pose a problem for listeners since speech is based on discreteness (knowing that a string of sounds forms a string of words) rather than continuity. This segmentation issue is thought to be partly overcome with lexical knowledge and contextual information. According to Mattys (2011), '[i]n this view, lexical candidates are activated in multiple locations in the speech signal -i.e. multiple alignment- and they compete for a segmentation solution that does not leave any fragments lexically unaccounted for' (p. 4). A second information source refers to broad prosodic and segmental regularities in the acoustic signal. Listeners use these as heuristics for identifying word boundaries. These may involve stress, phonotactics, or the position of a word boundary.

To sum up, listeners perform quite well compensating for the acoustic distortions that result from the three abovementioned problems. These do not seem to cause an important difficulty for everyday speech perception. Nonetheless, theoretical perspectives trying to account for the complexity of the acoustic signal and the effortlessness of perception differ considerably.

2.2. Observations Shaping Theoretical Thinking

Several lines of research that are relevant in evaluating the theoretical perspectives put forward are reviewed below. The research topics surveyed include categorical perception as well as phonetic, visual, and lexical and sentential context effects.

2.2.1. Categorical Perception

Liberman et al. (1961a, b, 1957) in an effort to examine how listeners perceive speech sounds presented synthetic CV syllables that varied in place of articulation along a continuum from /ba/ to /da/ to /ga/ asking listeners to identify which sound they could hear and discriminate between the two different sounds. The results indicated that listeners could perceive the sounds categorically by grouping them into discrete categories. These seemed to have abrupt perceptual boundaries while discrimination of stimulus pairs within the categories was poor compared to stimulus pairs that overlapped an identification boundary.

Categorical perception, as a result, was thought to be unique for humans (Liberman et al. 1967). Nonetheless, this assumption was weakened by evidence for categorical perception for non-speech sounds (Pisoni 1977, Miller et al. 1976) and speech-sounds by non-human species (Kluender, Diehl & Killeen 1987, Kuhl 1981). Specifically, VOT and place of articulation were found to be perceived categorically by both humans and animals. Concerning VOT, Pisoni (1977) constructed non-speech analogs of VOT stimuli that included of a lower and a higher frequency tone varying from -50-ms to +50-ms TOT (tone onset time). Adult listeners did not encounter any difficulties with this task while similar performance was observed for infants (Jusczyk et al. 1980). Kluender et al. (1987), Kuhl and Padden (1982), Kuhl (1981), and Kuhl and Miller (1978, 1975) provided evidence of categorical perception of VOT for animals that resembled that of adult listeners. With reference to place of articulation, Kuhl and Padden (1982) and Dooling et al. (1995) found that animals are able to discriminate between different phonemes in terms of place of articulation and specifically /b/-/d/-/g/ and /r/-/l/ respectively.

Moreover, language experience seems to be of crucial importance for categorical perception. Lisker and Abramson (1970) and Abramson and Lisker (1970) emphasised on cross-language differences in identification boundaries and discrimination peaks. By examining VOT perception among English, Spanish, and Thai native speakers, the researchers highlighted the fact that categorical perception of VOT results from language experience since listeners gradually become more conscious to phonetic differences that are important in their language and/or less conscious to differences that are not. In the languages under investigation, categorical perception was evident but the location of phoneme boundaries and associated peaks differed based on the language (different voice distinctions).

2.2.2. Phonetic Context

The effect of adjacent phonemes on the acoustic identifications of the target phoneme is an important factor in speech perception. Liberman et al. (1956) found that perception of plosive/glide distinction /b/-/w/ is affected by the duration and slope CV formant transitions, in which shorter transitions characterise plosive consonants. Along these lines is Miller and Liberman's study (1979) emphasising that a longer following vowel shifts the plosive/glide boundary toward longer transition duration resulting in better perception of plosives. Diehl and Walsh (1989) also proposed that the length of an acoustic signal is affected contrastively by the duration of the adjacent phonemes. This implies that if a phoneme is next to a long one, this must be short. The researchers comparing speech (plosive/glide) and non-speech stimuli found similar results between speech and non-speech performance that provide support for the durational contrast explanation of the stimulus length effect.

Adjacent phonemes may also influence the production of consonants since in natural connected speech phonemes are coarticulated. This may result in a change in terms of place of articulation of the specific consonants. Mann (1980) in a study with synthesised CV syllables investigated the perception of a /da/-/ga/ continuum. These syllables were preceded by the context syllables /al/ or /ar/. Results emphasised the influence of the preceding context since more /ga/ were observed following /al/ and more /da/ syllables were reported following /ar/. These shifts do not agree with the notion of coarticulation between adjacent phonemes since in production /al/ syllables result in more anterior or /da/ productions. Consequently, perception seems to compensate for the effects of coarticulation. Coarticulatory effects on acoustics and perceptual compensation are further evident in consonant contexts and vowel targets (Holt, Lotto, & Kluender 2000, Nearey 1989, Lindblom & Studdert-Kennedy 1967), vowel contexts and consonant targets (Holt 1999, Mann & Repp 1981), as well as vowel contexts with vowel targets (Fowler 1981).

2.2.3. Visual Context

A reference to visual information involving facial and lip movement must also be made in an effort to mention all the possible factors affecting speech perception (even if this factor is not directly related to the present study). In this context, Fowler, Brown, and Mann (2000) presented listeners with a /da/-/ga/ continuum that was preceded by perceptually ambiguous syllables between /al/ and /ar/. In this study, listeners had the opportunity to watch the speaker while talking and the results indicated that listeners depended on visual input for the responses. As a result, visual /al/ productions led to more /ga/ responses. Auditory-visual interactions were further reported by Stephens and Holt (2002) who presented listeners with an ambiguous context and CV sounds preceded by /al/ and /ar/. Listeners utilised visual input in this study as well while when presenting audio and video portions of Fowler, Brown, and Mann's stimuli with no auditory or visual context, the researchers reported similar results as those in Fowler, Brown, and Mann indicating auditory and visual interactions. McGurk and McDonald (1976) also emphasised on an auditory-visual interaction since when listeners were presented with an acoustic /ba/ while watching a face producing /ga/, they reported that what they could hear was /da/. The reason for such a response is that the place of articulation of /da/ is intermediate between /ba/ and /ga/.

2.2.4. Lexical and Sentential Context

Higher-order knowledge involving lexical and sentential contexts seem to further influence the identification and categorisation of phonemes and phonetic features particularly in cases in which the acoustic signal is ambiguous or degraded (Warren & Obusek 1971, Warren & Warren 1970). Specifically, Warren and Obusek (1971) cite evidence of phoneme restoration since in their study words were correctly perceived even though a phoneme was missing and was replaced by noise. Warren and Warren (1970) report similar results since participants could appropriately hear a word whose initial phoneme was degraded by relying on sentential context.

The abovementioned studies provide evidence that higher-level processes (*i.e.* morphology, semantics, syntax) interact with basic speech perception processes assisting the recognition of speech sounds and enabling the compensation of missing or noise-masked phonemes. This top-down approach emphasising on the importance of lexical information (Magnuson et al. 2003, Connine & Clifton 1987, Samuel 1981) is questioned by studies that point to no evidence for such top-down feedback or no reasons why such feedback should exist (Norris, McQueen & Cutler 2000, Massaro 1989, Oden & Massaro 1978).

2.3. Theories of Speech Perception: Phonemic Categorisation

2.3.1. Motor Theory

The Motor Theory (MT) (Liberman & Mattingly 1985, Liberman et al. 1967) constitutes the first effort to offer a convincing justification for the problem involving the lack of invariance of linguistic elements (*i.e.* features and phonemes) and acoustic cues. An example is provided with the consonant /d/ that may differ in its acoustic details across different phonetic contexts, but it is perceived the same by listeners, that is, falling in the same category. According to Dellatre, Liberman, and Cooper (1955), this happens because formant transitions of different /d/s, when extrapolated back to their convergence point (Potter, Kopp & Green 1974), have in common the frequency at their origin that reflects the articulators' position before the consonant release.

MT, thus, puts forward a one-to-one relationship between phonemes and articulation rather than acoustics. In this view, listeners can overcome the lack of invariance problem by identifying the speakers' intended gestures that may not be evident in the acoustic signal or observable articulatory movements (Liberman & Mattingly 1985) rather than depending only on the acoustic manifestation of these gestures. The McGurk effect (McGurk & McDonald 1976 – section 2.2.3) emphasising on an auditory-visual interaction supports this argument since in that case auditory perception was not noticeably changed by seeing the speaker's lips (articulatory gestures). Specifically, the McGurk effect (McGurk & McDonald 1976) indicates that listeners integrate visual speech information into the perception of speech automatically making use of all relevant types of information. The MT suggests, as a result, that the 'objects of speech perception are the intended phonetic gestures of the speaker, represented in the brain as invariant motor commands that call for movements of the articulators through certain linguistically significant configurations' (Liberman & Mattingly 1985: 2). Consequently, objects of speech perception are assumed to be invariant with respect to phonemes of feature sets and this kind of requirement is met only by motor commands. Speech perception seems to move gradually from phonemes to motor commands, to contractions of the muscles, to vocal tract shapes, and finally to acoustic signals (Liberman et al. 1967). Phonemes are thought to be in one-to-one correspondence with motor commands and muscle contractions, but the latter is not in one-to-one correspondence with vocal tract shapes due to coarticulation.

MT further posits that speech perception shares the same set of invariants as speech production and must, as a result, be closely related. However, this relation is innately specified (Liberman & Mattingly 1985). Therefore, this link seems to be a necessity for recognising speech as such. According to Liberman and Mattingly (1985), '[…] the candidate signal descriptions are computed by an analogue of the production process – an internal, innately specified vocal tract synthesizer […] – that incorporate complete information about the anatomical and physiological characteristics of the vocal tract and also about the articulatory and acoustic consequences of linguistically significant gestures' (26).

2.3.2. Direct Realist Theory

The Direct Realist Theory (DRT) (Fowler 1996, 1994, 1989, 1986, 1984, 1981) was proposed as an alternative to MT suggesting that the objects of speech perception are actual articulatory gestures obtained from the acoustic signal. Thus, listeners can perceive the consonant /d/ as the same even if it occurs in different phonetic contexts due to a commonality of gestures in those cases. The theory, following the general theory of direct perception (Gibson 1979, 1966), supports that speech perception can be defined in the same terms as visual perception of surface layout. According to Fowler (1996):

> perceptual systems have a universal function. They constitute the sole means by which animals can know their niches. Moreover, they appear to serve this function in one way: They use structure in the media that has been lawfully caused by events in the environment as information for the events. Even though it is the structure in media (light for vision, skin for touch, air for hearing) that sense organs transduce, it is not the structure in those media that animals perceive. Rather, essentially for their survival, they perceive the components of their niche that caused the structure (1732).

As a result, the speaker's gestures structure the acoustic signal that functions as the information medium through which the listener recovers the gestures. In that manner, DRT rejects MT's claims about the specialised and/or innate structures for speech perception since in this view, the signal is rich enough to specify the gestures that compose it and listeners can perceive these gestures just by identifying the relevant information. Since the information in the acoustic signal is directly inferred, the term 'direct' in DRT is used while 'realist' refers to the fact that listeners can recover the phonetic segments that are realised as sets of physical gestures.

With reference to speech production, DRT proposes that consonant and vowel gestures are coproduced. These coproduced gestures structure the acoustic signal in independent (albeit temporally overlapping ways) causing no difficulties for the listener to recover these gestures and their temporal sequencing.

2.3.3. General Approach

New empirical findings that could not be explained in terms of MT or DRT drew attention to the significance of general auditory mechanisms. Specifically, differences between particular speech sounds and perception of non-speech analogs of those speech stimuli were found (Mattingly et al. 1971, Liberman et al. 1961a, b) that were, though, explained as supporting MT (Liberman, Mattingly, & Turvey 1972, 1967). Nonetheless, Pisoni (1977), Miller et al. (1976), and Stevens and Klatt (1974) indicated that there are noticeable differences between perception of speech stimuli and non-speech stimuli given that they had critical temporal properties in common. Also, animals seemed to demonstrate aspects of speech perception (Kuhn & Miller 1978, 1975) that MT was exclusively attributing to humans (Liberman et al. 1972).

Consequently, different alternatives to the existing theories were proposed, which are referred to as the General Approach (GA). This approach seems to lack theoretical content depending to a great extent on counter-arguments and evidence to MT and DRT (Diehl, Lotto & Holt 2004). However, it supports that the same mechanisms are employed for speech perception and audition while the mapping between the acoustic signal and the linguistic information is not equivalent to or mediated by the perception of gestures. Based on GA, the consonant /d/ is perceived as the same across phonetic contexts due to the listeners' general ability to use numerous imperfect acoustic cues for categorising complex stimuli and achieving perceptual constancy. Therefore, the recovery of articulatory gestures or a special mode of perception are rejected in this approach. Evidence for this assumption is provided with birds that could respond to /d/-initial versus /b/- and /g/-initial syllables after being trained (Kluender et al. 1987).

2.4. Theories of Speech Perception: Phonemic Categorisation and Lexical Knowledge

2.4.1. Top-down Theories

As mentioned earlier, higher order processes (knowledge of words and contexts) can influence the perception of individual sounds. Samuel (1981) found that auditory perception changed when lexical information was present compared to when it was not. As a result, the speech system was assumed to be interactive in that information is not necessarily uni-directional but it is flowing both from bottom to top and top to bottom. The TRACE model (McClelland & Elman 1986) indicates this interaction since its three levels, namely features, phonemes, and words, involve bottom-up (from features to phonemes and from phonemes to words) and top-down (from words to phonemes and from phonemes to features) interactions but prevent lateral interactions (within each level). These three levels form a 'dynamic processing structure' (McClelland & Elman 1986: 175) that can simulate for a number of phenomena such as categorical perception, cue trading relation, phonetic context effects, compensation for coarticulation, lexical influence on phoneme identification/categorisation, and segmentation of embedded words (McClelland & Elman 1986).

Adaptive Resonance Theory (ART) (Grossberg & Myers 1999, Grossberg 1986) also suggests an interaction between sensory information and lexical knowledge. In ART, input activates items that are composed of feature clusters and these in turn activate list chunks that correspond to grouping of items such as phonemes, syllables, and words. List chunks feed back to items and items back to list chunks. Like TRACE, ART implies that interactions between levels are excitatory while within levels are inhibitory.

2.4.2. Bottom-up Theories

In bottom-up theories, information is processed at the lower levels while it is not affected by higher order processes. Therefore, the emphasis is placed on the individual phonemes. A model favouring bottom-up information processing is the Race model (Cutler & Norris 1979) according to which two sources of information, a pre-lexical and a lexical route, are responsible for phoneme identification. In the cases in which the sensory input is lexical (has a match in the lexicon) is read out from the lexical route that is assumed to be faster while if the sensory input is non-lexical (a non-word) is read out from the pre-lexical route. As a result, missing phonemes do not present a serious problem since the lexical route receives enough information to activate the target word.

The Fuzzy Logical Model of Perception (FLMP) (Massaro 1996, 1987, Oden & Massaro 1978) is also in line with bottom-up processing. This model supports that speech perception is influenced by all the available sources of information such as auditory and visual speech. These sources are first evaluated independently of each other while at a later stage they integrate. The former stage involves converting these information sources into features. Each feature reflects the degree to which the stimulus corresponds to each of the set of prototypes while then these features are integrated with each other they specify the degree of match of sensory input with each prototype (relative goodness rule).

The Merge model (Norris, McQueen, & Cutler 2000) proposes that the phoneme layer can be distinguished into an input layer and a decision layer. The former feeds forward to the lexical layer while the latter receives input from both the input layer and the lexical layer. In the phoneme decision layer, phonemic and lexical knowledge is integrated. In this model, lexical activation is affected by activation caused by the input layer that is in contrast with FLMP in which lexical activation does not depend on the activation degree of the component phonemes.

2.5. L2 Speech Perception

This review of the observations that have shaped theoretical thinking and theoretical perspectives in speech perception suggests that perceiving speech is the outcome of a set of highly sophisticated processing skills or structures. Infants by the end of their first year seem to have tuned to the perceptual categories of their L1 (Werker & Tees 1984), which could imply that attuning to the new L2 perceptual categories later on will be difficult and probably not as complete as for the L1 categories. Logan, Lively, and Pisoni (1991) indicated this with a study involving Japanese speakers of L2 English who had several difficulties acquiring the /r/-/l/ distinction.

As a result, several difficulties may arise when L1 users are confronted with an L2 due to the different phonemic inventories of the two languages. Attributing these difficulties to differences between the two phonological systems (negative transfer – section 1.3.3.) may explain why learning an L2 sound is more difficult when this differs from an L1 sound and why it is easier when the L2 sound is similar to the L1 sound. Nonetheless, L2 research on speech perception indicates that perceiving L2 sounds is not that straightforward since other linguistic and psychological factors need to be considered as well. This ability of L2 users to perceive similarities and differences between L1 and L2 sounds has led to the several theoretical models of speech perception and production.

Flege (1995) suggested that the accuracy of speech production is limited by the accuracy of perception. By examining the production and perception of vowels by Italian speakers of L2 English, Flege, McKay, and Meador (1999) established this link between production and perception. A theoretical model that attempts to account for this link is the Speech Learning Model (SPL: Flege 1995) that puts forward that a necessary prerequisite for accurate L2 segmental production is accurate perception. The model suggests that the phonemic inventories of the two languages are not that separate and that the languages occupy the same 'phonological space' (Bohn & Flege 1992). Thus, L2 speech learning is more challenging, as the phonetic space becomes committed to the L1. This implies that L2 sounds that are similar to L1 sounds will pose a problem to L2 users while sounds that are not that similar will be easier to learn. L2 users have difficulties establishing new perceptual categories for similar sounds since these will occupy the same phonetic space.

A second model emphasising on speech production and perception is the Native Language Magnet (NLM: Kuhl 2001, 2000, 1991). The hypothesis is that prototypes defined as 'good instances' of phonemic categories, have a unique perceptual status in that they have a stronger magnet effect (Kuhl 1991). Kuhl (2000) proposes that listeners can exploit specific auditory features and, as a result, perception is changed to sense language. Studies in SLA (Iverson et al. 2003, Frieda et al. 2000, Frieda et al. 1999) indicate that listeners judge L2 sounds based on their L1 and that listeners with different linguistic backgrounds will judge L2 sounds differently due to their different L1. Thus, linguistic experience seems to affect both L2 speech production and perception.

The Perceptual Assimilation Model (PAM: Best 1995) constitutes another attempt to account for the acquisition of L2 sounds. This model supports that L2 sounds are perceptually assimilated to L1 sounds and that this can occur in three ways: 1) categorised exemplar of some native phoneme, 2) uncategorised phoneme that falls between native phonemes, and 3) nonassimilable non-speech sound that bears no similarity to any native phonemes (Best, McRoberts & Goodell 2001). In brief, L2 users can assimilate new phones to their L1 phonological system by detecting articulatory-phonetic similarities to the phonological units and contrasts of the L1.

The abovementioned models attempt to explain how the L1 experience and the extent of L2 exposure influence the production and perception of L2 speech sounds. In contrast to the Critical Period, these models suggest that it is the tuning to the L1 sound system that renders L2 acquisition more difficult as the users get older and neutrally committed to L1 (Iverson et al. 2003). Users, however, can easily learn to produce or perceive L2 sounds with no discontinuity in L2 learning ability (Flege Yeni-Komshian, & Liu 1999) through natural or laboratory training (Logan, Lively, & Pisoni 1991), and even in cases in which L2 contrasts are not present in their L1 (Best, McRoberts, & Sithole 1988).

3. The Cypriot Greek (CG) variety

3.1. Cypriot Greek (CG)

In Greek-speaking Cyprus, which constitutes the geographical context under investigation, the variety used is Cypriot Greek (*henceforth* CG) or Kypriaka which is considered one of the major Greek dialects commonly used in modern times, along with Pontic and SMG (Standard Modern Greek). CG has evolved from Koine rather than the ancient Arcadocypriot dialect (one of the ancient Greek dialects) (Faucounau 2001) since the island was cut off from the Greek-speaking world several times because of invasions. Before the Turkish invasion in 1974, a number of local geographical varieties were also used. The subsequent occupation of the northern third of the island, though, that resulted in the displacement of refugees to the south along with the urbanisation of 60% of the population led to the fading of these local varieties (Papapavlou & Pavlou 2001).

The linguistic situation of the Greek-speaking Cyprus is of special interest since the linguistic code in use is not a ‘single homogeneous variety’ (Terkourafi 2001) but consists of elements of town speech (urban CG *koiné*), village speech (localised Cypriot varieties), SMG, and English. Specifically, CG is distinguished into ‘town’ and ‘village speech’ (Newton 1972b). The former variety that is also known as ‘urban Cypriot’ or ‘local Cypriot Koine’ (Karyolemou & Pavlou 2001, Kollitsis 1988) is used in urban centres and is closest to the standard form of SMG that is the language on which it is based (acrolect). ‘Village speech’ or ‘village Cypriot’ on the other hand, refers to the variety that is most remote from the standard form (basilect) even though it is commonly used involving a host of local varieties spoken in the rural areas.

Trudgill's pyramid model (1983) presents a similar linguistic situation mirroring the regional and social variation in England (Figure 6). Based on this model, there is greatest regional variability among speakers of lower working classes (low status accents and dialects) while the speech of upper-middle class members is closest to the standard variety (Received Pronunciation accent). Consequently, the greatest variability is found at the bottom of the pyramid whereas moving toward the top of the pyramid, these differences are reduced. Likewise, in Cyprus *koiné* (town speech) is the 'dominant variety' used by Greek Cypriots of all socio-economic backgrounds at home and at work nowadays and is more intelligible to SMG speakers than 'village speech' (Terkourafi 2001).

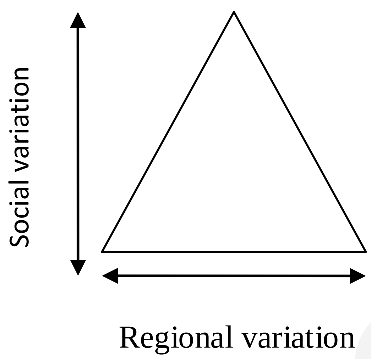

Figure 6: The pyramid diagram of regional and social variation in England (based on Trudgill 1983: 188)

Sivas (2003a) also recognises the existence of a number of linguistic varieties in Greek-speaking Cyprus. Specifically, she distinguishes between Cypriot Modern Greek that is used in more formal occasions, Urban Greek (also known as 'town speech' or 'local Cypriot koine') that is used for everyday communication, and other local varieties of the dialect that are mainly used in the countryside. However, she supports that the relationship between the varieties is more complicated since these linguistic varieties are not that distinct. Specifically, it is argued that the varieties are connected in a linguistic continuum by intermediate varieties (Figure 7). From this perspective, varieties are organised on a scale, with Cypriot Modern Greek labelled the 'acrolect' and local varieties labelled the 'basilect' while the whole intermediate zone constitutes the 'mesolect'. Urban Cypriot is thought to be the 'mesolect' but Sivas (2003b) argues that there are several intermediate varieties for the Urban Cypriot. Nonetheless, Greek Cypriots do not recognise the existence of this linguistic continuum but believe that the linguistic situation in Cyprus involves two Greek varieties, ‘Greek’ that includes both SMG and Cypriot Modern Greek and ‘Cypriot’ that refers to Urban Cypriot.

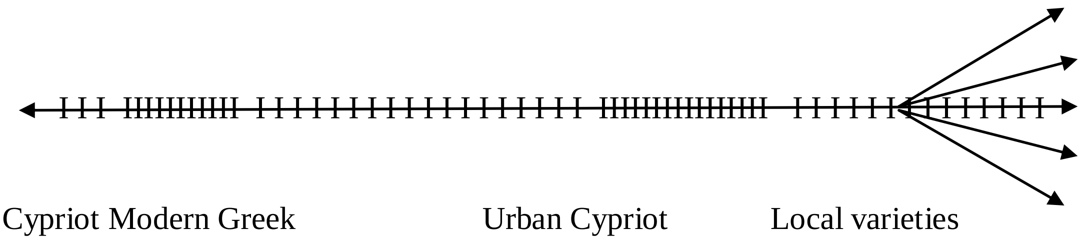

Figure 7: Sociolinguistic situation in Cyprus (adapted from Sivas 2003a)

According to the 2001 census, 91.7% of the native speakers responded that the language they speak best is Greek, which covers all varieties (Arvaniti 2006). CG and the official language of Greece, however, may not be mutual intelligible. The differences involve all levels of linguistic structure such as phonetics, phonology, morphology, syntax, as well as semantics/lexicon. Be that as it may, it is easier for Greek Cypriots to understand Greek speakers than vice versa (Papapavlou & Pavlou 1998) even though SMG is not their native language. The reason is because SMG is one of the two official languages of the Cyprus Republic since 1960, the other being Turkish and because it is acquired through formal schooling and is used in education, the media, and public documents.

This constant exposure of Greek Cypriots to SMG leads to an adequate level of mastery while the use of CG is limited to specific but very broad contexts. The use of these two linguistic codes in distinct domains is expected in communities where more than one linguistic code is used (Holmes 1992, Fasold 1984). CG is mainly used for daily communication among Greek Cypriots and less often in the media (Pavlou 2004) even though in the past few years a wider use of the dialect has been observed in the press and various television programmes. Nonetheless, since the dialect is primarily used for oral communication with the exception of folk poetry and folk literature, it does not have a standardised and codified system for writing (Pavlou & Christodoulou 2001). Moreover, Greek speakers are not familiar with CG and especially with the CG that is spoken among Greek Cypriots themselves (both ‘town’ and ‘village speech’) since when addressing Greek speakers, Greek Cypriots accommodate to their addressees. This becomes possible by using

'Cypriot Standard Greek' that refers to Standard Greek spoken in Cyprus and differs from SMG that is spoken in Greece and from both acrolectal forms of CG (Arvaniti 2006).

This diglossic linguistic situation between CG ('town' or 'village speech') and SMG (Papapavlou & Pavlou 2001) becomes more complicated when the role of English and its influence is taken into account. In Cyprus, English is used 'predominantly in response to the economic, cultural and symbolic forces of modernity […] and predominantly used by those with greatest socioeconomic standing' (McEntee-Atalianis & Pouloukas 2001: 23) while the influence is evident in the lexicon. This pragmatic function of English can partly be attributed to the fact that Cyprus was ruled by the British from 1878 until 1960, when the island gained its independence from Britain. It can also be due to the general use of the English language throughout recent history that has established it as one of the most important known mediums used for international communication. More specifically, the number of users of this international linguistic code is increasing to beyond one billion (Doğançay-Aktuna 1998).

The actual use of English has increased immensely in the last decades because of these reasons even though English in Cyprus is neither ESL (English as a second language), with the exception of particular professions, nor EFL (English as a foreign language). The effort to classify Cyprus as an ESL or EFL country does not have the desirable outcomes since the distinction cannot be absolute. This can be attributed to the fact that in Cyprus, speakers cannot use English as everyday speech that would render the specific linguistic code as a SL (second language). English is not a FL (foreign language) either, since it is not merely restricted in the classroom context as it occurs with other languages in Cyprus (*i.e.* French or German) but has also other uses. Sectors that reflect this use of English include education, administration, the media, as well as everyday vocabulary (Pavlou 2006). Concerning the educational sector, English is taught as a compulsory subject from grade 1 of primary school until the last class of lyceum. It is also a compulsory language requirement for admission to several Cycles (clusters of subjects) in tertiary education such as the Department of English Studies, Sociology and Political Science, and Economics. English is the language of instruction for the Higher Hotel Institute of Cyprus, the Higher Technical Institute, the Cyprus Forestry College, and the Mediterranean Institute of Management as well as for most private secondary and tertiary schools (Country Report 2004).

English is further used in major government reports even though Article 3 of the 1960 Constitution provides that all 'legislative, executive and administrative acts and documents' should be in the official languages of the Republic. Prior to 1989, though, English was used both as a court and legislative language. After the enactment of Law N.67/1988, Greek started to be used in the judicial proceedings and laws started to be translated from English into Greek (Karoulla-Vrikki 2005). English is finally employed in banking and health care, road signs, other public notices, and everyday vocabulary (Papapavlou 2001). With regard to the everyday use, English is in reality used in both the high and low domains of society while CG is mainly used in the low domains and SMG in the high domains (Pavlou 2006) indicating that the English vocabulary may be quantitatively more significant.

This situation leads Greek Cypriot speakers to form certain attitudes toward English. The bulk of research supports the view that Greek Cypriots hold more 'favourable attitudes' toward English than their native dialect (McEntee-Atalianis & Pouloukas 2001, Papapavlou 2001). These attitudes are addressed to the language itself or to the speakers of the language and are not based on linguistic criteria but on personal beliefs since they may originate from biological (innate dispositions), cultural (developed via inculcation), and functional (stereotypes that order a speaker's social world) biases (McEntee-Atalianis & Pouloukas 2001). Greek Cypriots understand the important role of English in modern society and that is why they want to learn the language or send their children from an early age to English private lessons. These attitudes largely motivate a widespread demand for private tuition in English. In 1998, 15.900 Greek Cypriots were registered for exams in English organised by the British Council. Additionally, 6004 were registered in English-medium tertiary institutions compared to 3997 registered in state tertiary institutions (Davy & Pavlou 1999).

Acquiring L2 English, though, may not be an easy task for Greek Cypriot speakers especially in terms of L2 phonological acquisition. This is attributed to the different phonetic and phonological systems of the two languages. This, as a result, emphasises the need to examine the possible differences between the two linguistic codes from a phonetic/phonological point of view.

3.2. The phonological systems of CG and English in comparison

The body of research devoted to the phonetics and phonology of CG is rather small and it mostly refers to geminates, phonotatics, and the issue of opacity due to 'glide-hardening', as well as comparing the phonetics of single and geminate consonants in CG and SMG (Armosti 2011, Arvaniti 2006, 2001a, 2001b, 1999, Tserdanelis & Arvaniti 2001, Arvaniti & Tserdanelis 2000, Harris 1996, Newton 1972a). The only research dedicated to plosive consonants, which is the scope of this investigation, refers to existing voicing contrasts in SMG and CG and the corresponding characteristics in VOT by preschoolers (Okalidou et al. 2010, Okalidou et al. 2002). The result of this shortage of phonetic research on CG, thus, is the limited information about the dialect's system.

Nonetheless, even though CG has a simple system of five vowels involving /i e a o u/, it has a rather complex consonantal system, which is outlined in Table 4. This includes consonants that are not present in SMG such as the post-alveolar consonants [ʃ], [ʒ], [ʧ], [ʤ] or consonants that are non-contrastive in SMG such as the palatal consonants [c], [j], [ɲ], [ʎ], and the trill [r] that may occur as allophones in some dialects or idiolects but not as distinct phonemes (Arvaniti, Kappa 2002). CG also includes geminates that are treated as separate phonemes (in most descriptions) and non-contrastive (allophonic) segments. As a consequence, 'it is clear that Cypriot has a rich and varied consonantal system' (Arvaniti 2010: 4).

	Labial	Alveolar	Postalveolar	Palatal	Velar
Plosive	p pʰ: *b*	t tʰ: *d*		c cʰ: *ɟ*	k kʰ: *g*
Affricate		Ts	ʧ ʧ: *ʤ*		
Fricative	f f: v v:	θ θ: ð *ð:* s s: z *z:*	ʃ ʃ: ʒ *ʒ:*	j *j:*	x x: ɣ *ɣ:*
Nasal	m m:	n n:		*ɲ*	*ŋ*
Lateral		l l:		*ʎ*	
Tap		ɾ			
Trill		R			

Table 4: Phonological system of consonants in CG (based on Arvaniti 2010: 4)

The most characteristic features involve:

1. the absence of the voiced plosives [b], [d], [g] which are replaced by:

a the voiceless plosives [p], [t], [k] as in [paˈpas] word-initially or [ˈate] intervocalically for SMG [baˈbas] *daddy*, [ˈade] *exhortative particle*,

b the prenasalised voiced plosives [^{m}b], [^{n}d], [^{ŋ}g] word-initially as in [^{m}baˈ^{m}bas] or [to^{m}baˈpa] for SMG [to$^{(m)}$baˈba]. This is because plosives are weakly voiced before nasals in CG (Newton 1972b),

2. the use of aspirated voiceless plosives as in [ˈkup^{h}a] or [ˈlak^{h}os] for SMG [ˈkupa] *bowl*, [ˈlakos] *well*,

3. specific phones that do not exist in SMG. These involve:

   a the palatoalveolar [ʃ], [ʒ]:

      i. loanwords such as [ˈʃut] or [reporˈtaʒ] for SMG [ˈsut] *shoot*, [reporˈtaz] *report*,

      ii. local and foreign names such as [ʹaʃa] *name of Cypriot village*, [ˈproeðros ʹbuʃ] *President Bush*,

   b geminate consonants when a word is spelled with two identical letters as in [poˈlli], [e'llaða] for SMG [poˈli] *many* [e'laða] *Greece*,

4. use of allophones for certain phones. Examples include the words:

   a ['ʃerin] for SMG ['ceri] *hand/arm*,

   b [ˈʤe] for SMG [ˈce] *and*,

   c ['ʒumen] for SMG ['zume] *we live*,

   d ['iʃa] for SMG ['isja] *straight*,

   e ['ðo^{ɲ}ɟa] for SMG ['ðo$^{(n)}$dja] *teeth*,

   f and [ma'ja] for SMG [ma'ʎa] *hair,*

and the most regional

   g ['a^{n}ʤelos] for SMG ['a$^{(ŋ)}$ɟelos] *angel*,

   h [θo'ro]/[xo'ro] for SMG [θo'ro] *see*,

   i [fo'ro] for SMG [xo'ro] *get into.*

English on the other hand, has a more complicated vowel system since it distinguishes between short and long vowel sounds. This involves twelve monophthongs /iː, ɪ, ɛ, æ, uː, ʊ, ɔː, ɒ, ɑː, ʌ, ɜː, ə/ and eight diphthongs /aɪ, eɪ, ɔɪ, aʊ, oʊ, ɪə, ɛə, ʊə/. With reference to the consonantal system, this is comprised of twenty-four consonant sounds as outlined in Table 5.

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Palatal	Velar	Glottal
Plosive	p b			t d			k g	
Affricate					ʧ ʤ			
Fricative		f v	θ ð	s z	ʃ ʒ			h
Nasal	m			n			ŋ	
Approximant				ɹ		j		
Lateral Approximant				l				

Other symbols: /w/ voiced labio-velar approximant

Table 5: Phonological system of consonants in English (based on Carr 1999: xviii)

CG and English segments can be organised into syllables which can either start with a single consonant followed by a vowel (CV-type syllables as in *telephone* [ti.'le.fo.no] and ['t^{h}ɛ.lə.fəʊn]), or with an empty onset (V-type syllables as in *angel* ['a.^{n}ʤe.los] and ['eɪn.ʤəɫ]). Branching onsets are also acceptable provided that certain phonotactic constraints are applied on the form that the branching onsets may take based on the Sonority Hierarchy (Carr 1999).

In CG,

1. a 2-member onset can consist of
   i. clusters that obey a minimal sonority distance ≥ 4 (Malikouti-Drachman 1984), such as [obstruent+sonorant] [pn, kn, pl, bl, pr, br, tr, dr, kl, kr, gl, gr] or [fricative+sonorant] [fl, fr, vl, vr, θn, θl, θr, ðr, xn, xl, xr, ɣn, ɣl, ɣr], *and*
   ii. 'antisonority' clusters whose members agree in voicing and violate the minimal sonority distance of ≥4, involving [obstruent+obstruent] such as [plosive+fricative] [ps, ks], [fricative+plosive] [sp, st, sk, ft, xt], and [fricative+fricative] [sf, sθ, sx, xθ, fθ].

CG, however, does not allow unaspirated [plosive+plosive] clusters such as [pt, kt]. The only exceptions involve clusters of voiceless aspirated plosives such as /p^{h}t^{h}/ and /k^{h}t^{h}/ as in [p^{h}t^{h}ixio] *degree* and [k^{h}t^{h}irio] *building*. Fricative+plosive clusters may be possible in certain cases as in [fteʹro] or [xtiʹpo] whereas SMG can also use plosive+plosive clusters as in [pteʹro] *feather/wing*, [ktiʹpo] *I hit.* More specifically, the clusters [pt] and [kt] in SMG are mainly used in formal vocabulary and are borrowings from Katharevousa while in Demotic the variants [ft] and [xt] are used instead for some words without this implying that [ft] and [xt] are always in free variation with [pt] and [kt] in SMG .

2. sCC clusters involving [obstruent+obstruent+sonorant] such as
   i. [fricative+plosive+sonorant] [skn, spl, spr, str, skl, skr] in word- or syllable-initial position and [ftr, xtr] in word-medial positions,
   ii. [fricative+fricative+sonorant] clusters [sfr, sxr, sxn, sθm, xθr] in medial positions.
3. 4-member onsets are not common, consisting of [fricative/plosive+fricative+plosive+sonorant] as in [fspl, fstr, kstr] in word-medial position.
4. Another point involves [j] that does not exist in CG, which uses [i] instead. This results in an extra syllable that can easily affect stress since in a word only one of the last three syllables can receive stress. Examples include the words [ɣa.ˈi.ða.ros] or [kar.ˈðia] for SMG [ˈɣaj.ða.ros] *donkey*, [kar.ˈðja] *heart*,
   a. [k]/[c] can also be used to replace [j] when this is preceded by /v/, /ð/, /θ/, /p/, or /f/ as in [karˈca] or [peˈθca] for SMG [karˈðja] *heart*, [peˈðja] *children*.

(Tsiplakou 2008, Arvaniti 2006, Kappa 2002, Terkourafi 2001, Newton 1972b).

With reference to English onset phonotactics,

1. the first segment must only be a plosive or a fricative and the second must be /l/, /r/, /j/, or /w/ as in */pr/, /pl/, /pj/, /br/, /bl/, /bj/, /tr/, /tw/, /dr/, /dw/, /kr/, /kl/, /kw/, /θr/, /θw/, /fr/, /fl/, /fj/, /sl/, /sj/, /sw/*. Consequently, /t/, /d/, and /θ/ cannot be followed by /l/ while voiced fricatives cannot occur in branching onsets.
2. /s/ + consonant + [j, w, r]. Nonetheless, /s/ occurs in the coda position preceded by an unrealised nucleus (degenerate syllable) so [s] and C(C) do not belong in the same syllable (Sonority sequencing).

Another point is that both languages allow closed syllables such as ['hɒt] and [zes.'tos]), and open syllables such as ['vɛɹi] and [po.'li]). Nonetheless, in CG most words end with a vowel while the only consonants that can occur as coda word-final are the coronal segments [s, n], *e.g.* [ka.'los] *good* and [mi.'lun] *they talk*. The only exceptions involve borrowings of foreign origin such as computer, golf, or tanks. Word-internal codas such as ['ðer.ma] *skin* and ['ef.ko.lo] *easy* are also present in the dialect given that these are weaker than the following onsets (Kappa 2002). In English, however, a word can finish with a vowel as in *bee* ['bi:], a consonant as in *pet* ['p^hɛt], two consonants as in *bank* ['bæŋk] (sequence of plosives, sonarants, coronals), three consonants as in *sixth* ['sɪksθ] (usually /t, s, θ/), or four consonants as in *sixths* ['sɪksθs] (usually /s, t, d/).

4. Plosive Consonants

4.1. The plosive system of CG and English

An area of special interest, as it becomes evident from this brief comparison of the phonological systems of CG and English, refers to plosive (or stop) consonants. Even though these consonants are among the most common speech sounds in languages, their phonetic identifications may vary from one language to another as it happens with the languages under investigation.

Plosive consonants are oral sounds since the soft palate is raised and air from the lungs cannot pass upwards into the nasal cavity. As a result, the air can escape through the oral cavity. These sounds share the same manner of articulation, namely they are produced by a complete closure of the airflow in the vocal tract at some position in the mouth (place of articulation) during which there is silence or a low-frequency hum (voicebar/prevoicing). This closure is then released when the vocal tract opens, allowing air to escape through the mouth with a slight 'explosion' (hence the name plosive consonants). These consonants can further be identified by voicing and place of articulation (Oden & Massaro 1978). The former refers to whether or not sounds are produced with vocal fold vibration. In the cases there is vibration, the sounds are voiced while if there is not the sounds are said to be voiceless. Place of articulation refers to 'the points at which the flow of air can be modified' (Carr 1999: 2).

Even though the symbols for plosive consonants are present in both linguistic codes, they differ in orthography and also have a different allophonic or phonemic value in each variety. With reference to English, there are six plosive consonants distinguished by place of articulation in bilabials (/b,p/) produced with the lower and upper lip coming together to form a complete closure, alveolars (/d,t/) produced when the tip of the tongue and alveolar ridge form a closure, and velars (/g,k/) produced when the back of the tongue contacts the soft palate or velum (Carr 1999). These fall into two voicing categories that are phonemically different involving the voiceless unaspirated [p], [t], and [k] and the voiced [b], [d], and [g]. Nonetheless, the phonetically different categories in English are three since there are also aspirated plosives. Aspiration, though, is not a contrasting feature in English and so there is no lexical distinction between aspirated and unaspirated plosives (*i.e.* spin *vs.* pin) even though there is phonetic difference (Fung 2004).

In CG, however, there are eight plosive consonants in bilabial [p], [pʰ:], alveolar [t], [tʰ:], palatal [c], [cʰ:], and velar [k], [kʰ:] (Arvaniti 2010, Newton 1972a). Based on these descriptions, aspirated voiceless plosives are distinct phonemes found in word-initial or intervocalic positions since consonant length is a contrastive parameter. Examples can be the words [ˈkati] (something) *vs.* [ˈkatʰ:i] (cats) and [kuˈpi] (oar) *vs.* [kuˈpʰ:i] (small bowl). Additionally, in CG there are no voiced plosives (no prevoicing) unlike English (Carr 1999) and SMG (Okalidou et al. 2010, Kong, Beckman, & Edwards 2007, Arvaniti 2007, 1999, Mennen and Okalidou 2006). These are pronounced as their voiceless counterparts or as prenasalised voiced plosives (Arvaniti 2006, Newton 1972a).

Nonetheless, other descriptions maintain that voiced plosives do exist in CG (consistent pre-voicing) (Okalidou et al. 2010, Botinis et al. 2004). Based on these accounts, there are three voicing categories in the dialect. The first category involves voiced plosives that may also be called 'prenasalised' because their underlying form is considered to be a cluster including a /nasal+plosive/ while the other two categories are distinguished based on consonant length (singletons *vs.* geminates). More specifically, the three categories include the voiced, aspirated plosives preceded by other voiced phonemes such as /m/ or /z/ and followed by a vowel as in [kuˈᵐbi] (button), the voiceless, aspirated, geminate plosives as in [kuˈpʰ:i] (small bowl), and the voiceless, unaspirated plosives as in [kuˈpi] (oar) (Okalidou et al. 2010, Newton 1972b).

Plosive consonants in CG, as a consequence, seem to differ considerably when compared to their English counterparts both in place of articulation and voicing. These differences may be the reason for the difficulties Greek Cypriots encounter in their effort to acquire L2 English, and specifically the plosive system of the L2. Therefore, an examination of the different acoustic-contextual information that may be available to L2 listeners and its effect seems to be mandatory at this point.

4.1.1. Voicing contrast

With reference to the voicing feature in plosive consonants, there are different accounts supporting that voiceless plosives are more easily produced and perceived compared to the voiced counterparts. Specifically, voiceless consonants are considered to be less marked and, thus, more naturally phonologically speaking than the voiced ones (Chomsky & Halle 1968). Based on the myoelastic-aerodynamic theory of phonation (van den Berg 1958), vocal fold vibration occurs when there is enough pressure drop and airflow across the vocal folds. Since in the case of plosive consonants this condition is not met, voiced plosives are produced with difficulty and are, thus, considered as less natural than voiceless (Ohala 1994, 1983). Studies on L2 acquisition provide evidence for this hypothesis since L2 users acquire voiceless consonants before voiced (Grijzenhout & van Rooij 2000, Broselow, Chen & Wang, 1998, Wissing & Zonneveld 1996, Wang 1995, Yavas 1994, Eckman & Iverson, 1993, Broselow & Finer 1991, Flege, McCutcheon & Smith 1987, Flege & Davidian 1984, Eckman 1981, Hecht & Mulford 1982, Macken & Ferguson 1981).

Perceptual studies emphasise on the importance of VOT, F1 onset frequency, F0 contour, or aspiration energy as acoustic cues for voicing (Repp 1979, Lisker et al. 1977, Lisker 1975, Haggard, Ambler & Callow 1970). These cues provide equivalent information about the voiced/voiceless distinction (Repp et al. 1978, Dorman, Studdert-Kennedy & Raphael. 1977). VOT, the period between the plosive closure release and the beginning of voicing, is the primary acoustic cue for the voicing distinction. Three patterns for VOT production are evident involving the long voicing lead in which phonation begins before the oral release (voiced plosives), the short voicing lag in which phonation begins just after the oral release (voiceless unaspirated plosives), and the long voicing lag in which phonation begins after the oral release (voiceless aspirated plosives). Thus, VOT production is shorter for voiced plosives. In English, plosives can be produced with a long voicing lead and a short voicing lag (voiced vs. voiceless) (Okalidou et al. 2010). In CG, though, the situation is more complex regarding plosive consonants. The two views proposed for the plosive system of CG agree on the presence of short versus long lag times but there is disagreement whether voiced plosives are contrastive segments.

According to Lisker (1986), the timing relation between plosive closure release and beginning of voicing produces several acoustic cues manifested mainly in formant transitions differences. Studies in the effects of F1 (first formant) transition and frequency at the beginning of voicing seem to influence the perception of the voicing contrast in English (Lisker et al. 1977, Summerfield & Haggard 1977, Stevens & Klatt 1974). Based on these studies, when the VOT is equal voiced plosives are characterised by a longer F1 transition and/or lower F1 frequency at the beginning of voicing while plosives with shorter F1 transitions and/or higher F1 frequency at the beginning of onset will be classified as voiceless. As a result, between VOT and F1 transitions there seems to be a trading relationship (Repp 1982).

F0 (fundamental frequency) is also thought to be a useful cue for voicing in plosives (Whalen et al. 1993, Ohde 1984, Haggard et al. 1970). Studies in fundamental frequency indicate that a low rising F0 characterises voiced plosives whereas a high falling F0 characterises voiceless plosives. Regarding aspiration energy, it is suggested that voiceless plosives have a greater articulatory force or louder burst compared to voiced, which is thought to be a characteristic for voicing (Lisker & Abramson 1964). In voiceless plosives, aspiration is evident during the period of closure but this does not occur in their voiced counterparts (Klatt 1975).

The above accounts, thus, suggest that voiceless plosives may be more easily perceived and produced by L2 users. Both the linguistic naturalness notion that depends on theory of markedness (Ohala 1983, 1974) and the perceptual studies emphasising on the various acoustic cues that listeners make use of imply that L2 users will have less difficulties acquiring voiceless plosives of L2 English.

4.1.2. Place of articulation

In addition to voicing contrast, VOT differs with place of plosive articulation (Shimizu 1996, Kent & Read 1992, Jakobson & Waugh 1979, Fant 1973). The different places of articulation are illustrated in Figure 8.

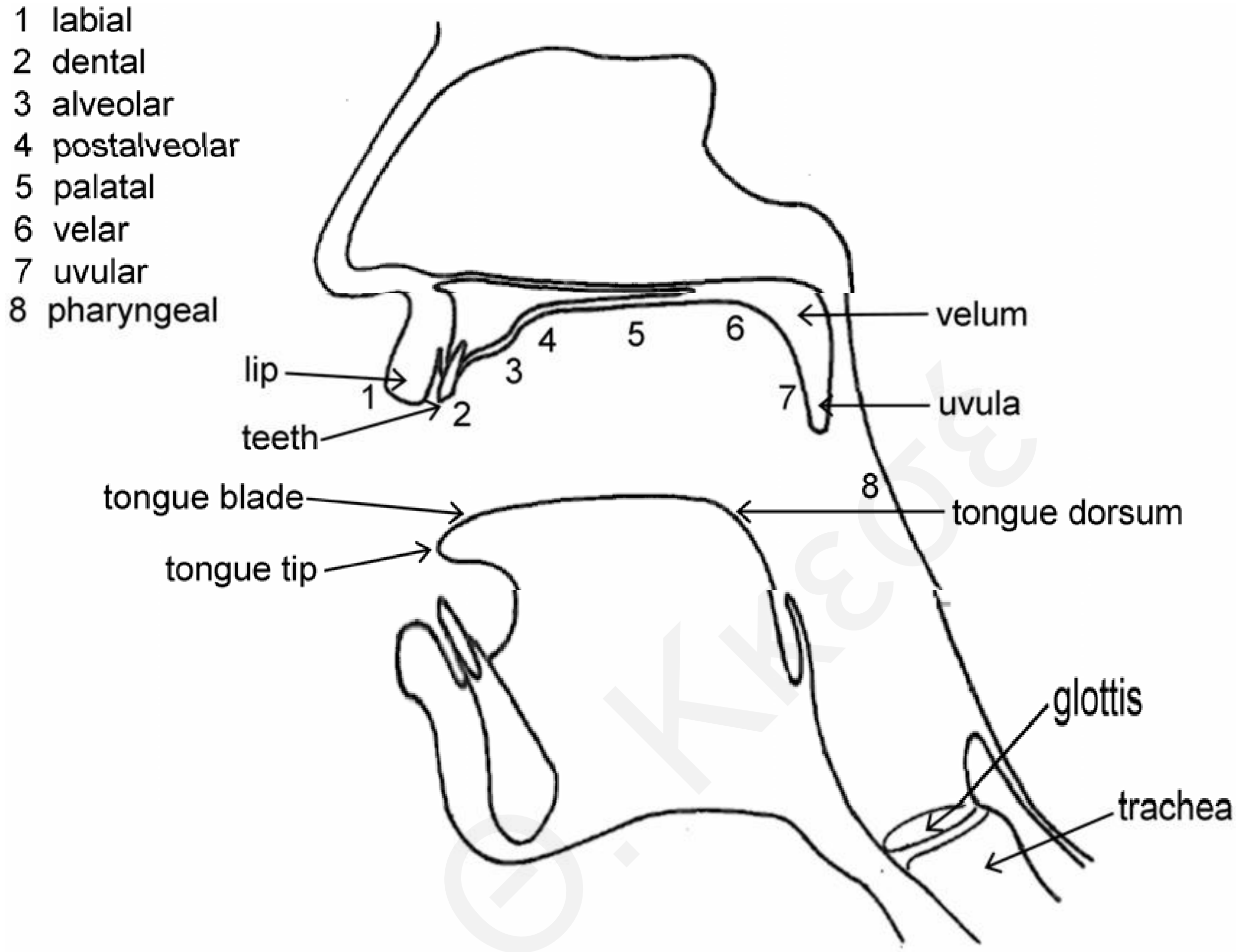

Figure 8: Midsagittal vocal tract showing the major places of articulation (adapted from Clark et al. 2006).

Specifically, velar plosives are produced with the longest VOT values, while bilabial plosives are associated with the shortest VOT values (Klatt 1975, Lisker & Abramson 1964). Cho and Ladefoged (1999) suggest that this characteristic is universal and it can be attributed to the areas of laws of aerodynamics (Hardcastle 1973), speed of movement of various articulators (Hardcastle 1973), extent of articulatory contact (Stevens 1998), and temporal adjustment between the duration of the plosive closure and VOT (Maddieson 1997).

Based on the laws of aerodynamics, the reason for the long VOT that characterises velars is the rather small supraglottal cavity behind the constriction. Therefore, greater air pressure builds up in the vocal tract compared to bilabial and alveolar plosives (Maddieson

1997, Hardcastle 1973) since the supraglottal cavity becomes smaller and the air pressure takes a longer time to fall to a sufficient level for the beginning of vibration. Further, the tongue dorsum, which is the articulator responsible for the production of velars, moves more slowly than the lips associated with the production of bilabials or the tongue tip responsible for the alveolar production due to its bigger mass. Consequently, air escapes at a slower rate after the release of the velar plosives resulting in a slower rate of reduction of supraglottal pressure. With reference to the contact area between the tongue dorsum and the soft palate, that is considerably larger when compared to the lips (for bilabials) implying that the rate of increase in velocity of air is slow contributing to a slower rate in the drop of the supraglottal pressure (Stevens 1999). All these factors favour longer VOT values for velar plosives and indicate that VOT values are sensitive to the place of articulation.

Both the CG and English plosive systems involve bilabial, alveolar, and velar consonants. CG also involves palatal consonants that are not present in English. The implications for users of L2 English, thus, suggest that velar plosives can be produced and perceived easier since they are phonologically less complex and less marked than their bilabial and alveolar counterparts. Bilabials in particular are assumed to be the most difficult to be acquired because of the shortest VOT values they are associated with.

4.1.3. Adjacent phoneme

The voicing and place of articulation features imply that plosive consonants vary across CG and English (and languages in general). Nonetheless, differences may also exist within each language since 'phonetic perception is not accomplished, phone by phone, in a simple progression through the acoustic signal' (Miller & Liberman 1979: 401). Even though phonemes constitute the minimal units of speech in a language that distinguish one word from another, language users are confronted with long stretches of sound during continuous speech. As a result, acoustic information specifying one phoneme differs considerably depending on the surrounding phonemes.

In continuous speech, the articulatory movements seem to depend on the preceding and following phonemes. Specifically, the articulators are in a different position for the preceding phoneme and are getting ready for the following phoneme. This implies that the target phoneme may have different places of closure when occurring in different phonetic sequences (Mann 1980). This effect, as already mentioned, is known as coarticulation (section 2.1). With reference to plosive consonants, it has been suggested that adjacent phonemes may function as reliable cues for voicing. Specifically, a preceding long vowel cues a voiced plosive while a preceding short vowel cues a voiceless plosive (Peterson & Lehiste 1960, House & Fairbanks 1953). Regarding consonants, in a consonant cluster such as [sp], the two phonemes will be shorter than when occurring in other contexts (Klatt 1976, Haggard 1973).

The perceived place of articulation is also believed to be influenced by an adjacent vowel (Repp & Mann 1978, Dorman, Studdert-Kennedy & Raphael 1977, Kunisaki & Fujisaki 1977, Fischer-Jorgensen 1954, Cooper et al. 1952). Plosives may have different places of closure when they occur before or after a vowel. Velar plosives in particular receive a more forward place of closure when the following phoneme is a front vowel such as [i] than a back vowel as [a] (Gay 1977, Öhman 1966). This fronting of velars results in release bursts that are higher in frequency. Additionally, when the preceding phoneme is [s], the plosives [t] and [k] receive a more forward place of articulation than when the preceding phoneme is the affricate [ʃ] (Repp & Mann 1978). Perceived place of plosive closure is further influenced by a preceding liquid (Mann 1980) that seems to affect the production of a following plosive (see section 2.2.2).

Following this line of research, it can be assumed that Greek Cypriot listeners of L2 English are able to make some linguistic decisions regarding the perception of plosives in terms of voicing and place of articulation based on the information provided by the adjacent phonemes.

4.1.4. Lexical context

Moving to the word level, plosives in word-initial position (and generally consonants) are believed to be more easily identified than plosives occurring later in words. Syllable-position, stress patterns, and word-position are provided as factors that enhance 'the acoustic properties of phonetic features at the beginning of words' (Gow, Melrold & Manuel 1996: 1).

With reference to syllable-position, word-initial plosives in syllable-initial position provide more salient acoustic evidence about phonetic features. An example involves voicing and the fact that in syllable-initial plosives, VOT and the onset frequency of the first formant are considered to be salient cues for distinguishing voiced and voiceless plosives (Summerfield & Haggard 1977, Lisker 1975). For syllable-final plosives, though, VOT may not be a reliable cue for voicing since it may not be released in the coda position. Whereas voiceless plosives in syllable-initial position are produced with the vocal folds being apart at the plosive release, in syllable-final plosives a constriction of the glottis is often observed that can cue voicelessness. This results in devoicing of syllable-final plosive consonants. Further evidence is provided with the place of articulation for plosive consonants that is conveyed by release bursts and formant transitions in syllable-initial plosives. Nonetheless, syllable-final plosives can occur without a release burst.

Concerning stress, it has been suggested that it increases the VOT for syllable-initial voiceless plosives. In English, voiceless plosives are aspirated in the stressed syllable-initial position but they are never aspirated when following a stressed vowel while vowels are often reduced in unstressed syllables. Further, the duration of the constriction phase of consonants is increased for stressed (Umeda 1977) and initial (Byrd 1966) syllables. Increased duration of consonant constriction implies that features such as place features will be present for more time enabling the listener to process the signal before the articulation of the next phoneme and will minimise the adjacent phonemes' effect (coarticulation).

Additionally, word-initial phonemes seem not to be influenced by phonological processes such as assimilation, neutralisation, and deletion compared to segments in other positions while they seem to guide the perception of words in continuous speech. In that manner, listeners do not proceed to one-to-one mapping between the acoustic phonetic and lexical representations.

The abovementioned factors are consistent with the Good Start model (Gow & Gordon 1995) suggesting that word-initial phonemes (or word onset) are perceptual 'islands of reliability' in continuous speech and they can drive lexical mechanisms that enable listeners to identify words even though other parts of the speech stream are not that reliable.

4.1.5. Sentential context

Continuous speech involves words embedded in sentences rather than words or phonemes presented in isolation. Even though in such conditions speech perception is expected to be distorted given that listening conditions are usually less than ideal and speakers concentrate on content rather than form, still the listener is capable to understand what has been said without any significant difficulties.

Successful everyday speech perception, as a result, seems to be attributed to the listeners' ability to make use of sentence context. Listeners by using context manage to decode a word in a sentence even if this may not clearly be produced. In other words, the identity of a target word within a sentence may be inferred by the use of semantic and syntactic information. Evidence for a context effect in speech perception is provided with studies that present words in isolation and in sentences to listeners under auditory or auditory-visual conditions. Taken together, these studies emphasise on the easier identification of words presented in sentences rather than of words in isolation (Boothroyd & Nittrouer 1988, Miller et al. 1951).

Given the importance of context in facilitating speech perception, a question that may arise involves the position of a word in a sentence. The location of a word in larger prosodic domains such as utterances seems to be an important determinant of speech recognition. Specifically, words occurring at the beginning or end of utterances are longer and less likely to be reduced compared to utterance-medial words (Bell et al. 2003). Effects such as initial strengthening (Byrd et al. 2000, Fougeron & Keating 1997) and final lengthening (Ladd & Campbell 1991, Crystal & House 1990, Klatt 1975) suggest evidence for the effect of position. In initial and final positions, constriction formation and release durations are longer (Byrd et al. 2000, Byrd & Saltzman 1998) while larger movement displacements and greater lingualpalatal contact are also evident (Keating, Wright & Zhang 1999, Byrd & Saltzman 1998). Specifically, Keating, Wright and Zhang (1999) pointed to an increased linguapalatal contact in utterance-initial position and Cho and Keating (2001) indicated that consonants in initial position have more extreme and longer articulations than in other positions.

Summary: second language phonology and speech perception approaches

Acquiring the phonological system of an L2, thus, seems to be a very challenging task especially in the cases in which specific L2 sounds do not exist or are non-contrastive in the L1. In an attempt to account for these difficulties encountered by L2 users, the two approaches of second languagephonology and speech perception seem to be of crucial importance.

According to second language phonology, L2 users are able to construct a system of knowledge referring to what they know and not just to what they can do. This mental representation system involves more than pronunciation but linguistic constraints such as the notion of CPH suggest that after a specific period the cortical plasticity of the motor and auditory systems become more limited (Simmonds, Wise & Leech 2011). The formation of representations of L2 speech sounds, as a result, may be less accurate resulting in the inability of distinguishing perception of certain phonemes. Specifically, L2 sounds that are not present or are 'phonologically ungrammatical' in L1 are assimilated to the closest acceptable form in the L1 (Dupoux et al. 1999). In the context under investigation, the difficulties encountered by L2 users when it comes to plosive consonants in English may be attributed to a deficit at the mental representation level.

On the other hand, the speech perception approach draws attention to the acoustic signal and the fact that it contains a number of acoustic cues that must combine in order to differentiate speech sounds belonging to different phonetic categories. Attending to these cues can lead to a reliable discrimination of speech sounds. L2 users, however, seem to employ other or fewer cues than L1 users (Cutler, Lecumberri & Cooke 2008) since L2 users exhibit some degree of L1 influence on their weighting of acoustic cues in perception. Specifically, cases of L2 contrasts involving two speech sounds that can be assimilated to a single L1 phonological category are of special interest since they are the most difficult for L2 users to perceive. Under this perspective, L2 users have difficulties perceiving English plosives due to acoustic-related reasons and specifically the fact that they do not attend to the acoustic cues or set of cues necessary for plosive identification since these may differ from their L1. The perception of a new L2 contrast, as a result, is influenced by the role of the acoustic cues in the L1 especially at the beginning stages of the L2 acquisition. However, as the perceptual system becomes tuned to the phonetic repertoire of the L1 during the first year of life, this implies that distinguishing between phonemes in the L2 that are absent or are realised differently in the L1 becomes increasingly difficult (Simmonds, Wise & Leech 2011). In such cases, as already mentioned, L2 phonemes may be assimilated into L1 forms (Dupoux et al. 1999). These observations indicate that the motor and sensory aspects (as involved in control of the articulators) of L2 speech production are clearly susceptible to a 'critical period' since it is much easier for younger children to master L2 speech compared to adults. Nonetheless, Flege (1981) argues against this loss of plasticity suggesting that the actual reason is the incorrect use of acoustic models of L2 due to L1 transfer (in Scovel 1988). In the cases in which L2 users adapt their phonetic model of L2 phonemes to be less affected by L1 phonemes, this problem will be overcome. However, Flege (1981) accepts the fact that there would still be differences between the perception and production of L2 users and that of L1 speakers.

By investigating L2 English plosives, thus, this study aims at examining which of the two approaches is responsible for the context under investigation or whether both can be the source for these difficulties. Specifically, Greek Cypriot users of L2 English seem to encounter several difficulties identifying the L2 contrast involving plosive consonants correctly. This problem may be due to deficits in the L2 mental representations (second language phonology approach), because of acoustic-related reasons (speech perception approach), or because of both. In an effort to answer this question, plosive consonants are examined in two different contexts in which the emphasis is on the factors reviewed above (sections 4.1.1.-4.1.5).

CHAPTER THREE: RESEARCH METHODOLOGY

Introduction

This chapter describes and justifies the methodological approach used in this study. Firstly, there is an attempt to present the research questions and hypotheses to be tested with the tasks developed. Then a detailed exposition of the research design outlining the rationale for the choice of a longitudinal quantitative study is discussed. The chapter proceeds with a description of the tasks developed, sampling process, and data collection and administration. Finally, the intended analysis strategy including the data analysis methods and appropriate statistical techniques adopted are introduced to test the objectives of this quantitative study.

1. Research questions and hypotheses

The theoretical perspectives and previous studies (see Ch. 2) lead to the understanding that the identification of plosive consonants seems to differ depending on various factors (Cho & Ladefoged 1999, Stevens, Keyser & Kawasaki 1986, Klatt 1976, Hardcastle 1973, Peterson & Lehiste 1960, Fischer-Jorgensen 1954). Based on the understanding of these theoretical perspectives and previous studies with regard to plosive consonants, the following quantitative research question was formulated for the present study:

1. What are the factors that affect the identification of plosive consonants for CG users of L2 English?

This question was then sub-divided into five alternative[10] directional[11] hypotheses. Specifically:

a. CG users of L2 English would perform better in identifying voiceless (apirated) plosives /p t k/ than their voiced counterparts /b d g/. Voiceless plosives are thought to be less marked and more natural than voiced plosives (Ohala 1983, Chomsky & Halle 1968) and that is why they are acquired first by L2 users (Hecht & Mulford 1982, Macken & Ferguson 1981). Also, acoustic cues, such as VOT, F1 onset frequency, F0 contour, or aspiration energy lead to the voiceless/voiced distinction (Repp 1979, Repp et al. 1978, Dorman, Studdert-Kennedy & Raphael 1977, Lisker et al. 1977,

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[10] An alternative hypothesis involves making a prediction about the expected outcome for the population of the study and usually results from prior literature and studies on the topic.

[11] Directional hypotheses involve making an expected prediction in which the direction of the effect of the variable is given.

Lisker 1975, Haggard, Ambler & Callow 1970). Finally, in CG there is disagreement whether voiced plosives are contrastive segments (Okalidou et al. 2010, Kong, Beckman & Edwards 2007, Arvaniti 2007, 1999, Mennen & Okalidou 2006).

b. Discrimination of bilabial /p b/, alveolar /t d/, and velar /k g/ plosives should be different for CG L2 users with performance being superior in velar plosives. The latter group generally exhibits longer VOT values (Klatt 1975, Lisker & Abramson 1964) that render the specific consonants less marked and phonologically less complex than bilabial and alveolar plosives. The longer VOT values associated with velar plosives are thought to be a universal characteristic (Cho & Ladefoged 1999) that is attributed to the areas of laws of aerodynamics (Hardcastel 1973), speed of movement of various articulators (Hardcastle 1973), extent of articulatory contact (Stevens 1998), and temporal adjustment between the duration of the plosive closure and VOT (Maddieson 1997).

c. Identification of plosives will be superior in word-initial position (*e.g.* pacing /ˈpʰeɪsɪŋ/) compared to other parts of words such as word-medially (*e.g.* calipers /ˈkʰælɪpəz/ or word-finally (*e.g.* grippe /gɹiːp/). Word-initial plosives differ from other parts of words since they provide more robust and redundant evidence about phonetic features, are not influenced by phonological processes, such as assimilation, neutralisation, or deletion and are, as a result, phonologically more stable than plosives in other positions while they may activate lexical representations that facilitate word perception and attending to new information (Gow, Melvold & Manuel 1996).

d. Identification of plosive consonants by CG L2 users in syllable onset position will be superior compared to the same consonants in syllable coda position as in the minimal pair *sighting* /ˈsaɪtɪŋ/ - *siding* /ˈsaɪdɪŋ/ *vs. lucent* /ˈluːsənt/ - *loosened* /ˈluːsənd/. This is attributed to phonetic features that are thought to be clearer for syllable onsets than for codas (Manuel 1991, Ohala & Kawasaki 1984). Specifically, place of articulation and voicing cues are more salient in syllable onset position. Whereas place of articulation for plosives is conveyed by both formant transitions and release bursts for syllable onsets, in syllable codas plosives may be produced without a release burst while for voicing, VOT that is a perceptual salient cue for syllable onsets may not be released in syllable codas.

e. Words occurring at the beginning of utterances are expected to be more easily identified by CG L2 users than words occurring in the middle or end of utterances (*e.g.* Croup is a respiratory disorder that normally occurs in the children in the age group of one to five / If we disburse their bonuses, maybe the angry crowd will disperse). Plosives in initial-utterance position are said to be longer in total duration, constriction duration, and time-to-peak velocity (Bell et al. 2003) while increased strengthening is also evident (Keating et al. 2003, Byrd et al. 2000, Fougeron & Keating 1997).

A two-alternative forced word identification task and a words-in-sentences identification task were conducted to test hypotheses (a)-(d). Hypothesis (e) was tested only with the words-in-sentences identification task due to the nature of the hypothesis that involved merely utterances and not isolated words (word identification task). The present study, therefore, involved two tasks, the word identification task and the words-in-sentences identification task.

The five aforementioned hypotheses[12] constituted the first phase of the study aiming at identifying the several factors that influence the identification of plosive consonants by CG users of L2 English as these were manifested in the two tasks. Differences were examined in the dependent variable (percentage of correctness) thought to be caused by the independent variable (five aforementioned factors). In the second phase of the study, the written errors of the CG users obtained from the words-in-utterances identification task were analysed and the findings from the two analyses were interpreted in terms of second language phonology and speech perception approaches. In that way, this component sought to answer the following quantitative research question:

2. What are the types of errors in the second identification task?

Both quantitative research questions aimed at answering the question of how the difficulties met by CG speaking L2 users of English can be interpreted, namely if these are the result of second language phonology effects or speech perception difficulties. Based on the second language phonology approach, these difficulties are the result of a deficit at the mental representation level while based on the speech perception approach, these are due to acoustic related reasons since L2 users do not attend to the acoustic cues that are of crucial importance for the identification of phonemes. By examining, thus, the factors and types of errors of CG

[12] Factors such as stress and context were not examined due to the insufficiency of the data while the acoustic dimension (*i.e.* VOT, plosive closure duration, vowel duration) that often distinguishes voiceless and voiced plosives manifested in the adjacent phoneme factor (preceding and following) was not measured.

L2 users the study seeks to answer which of the two approaches can provide a convincing justification for the context under investigation or whether these approaches can actually complete each other.

2. Research design

Developing an appropriate research design is essential to align the planned methodology to the research problems (Churchill & Iacobucci 2004, Malhotra 1999). A research design is defined as 'a set of advance decisions that makes up the master plan specifying the methods and procedures for collecting and analyzing the needed information' (Burns & Bush 2002: 120).

The study involved non-experimental[13] research (survey) with a longitudinal design. Non-experimental research was thought to be more appropriate because there were many independent variables (stated in the hypotheses) needed to be studied that could not be manipulated. The aim was to provide quantitative or numeric results of a population by studying a sample of that population. From those results, the researcher could generalise or make claims about the population (Creswell 2003). The longitudinal design of the study allowed the repeated observations of the same variables over long periods of time. Specifically, the longitudinal study involved a trend study since it samples different groups of people at different points in time from the same population.

Quantitative research was used that depends on numerical data (Charles & Mertler 2002). In these cases, the researcher employs postpositivist claims for developing knowledge such as 'cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories' (Creswell 2003: 18). The researcher uses strategies of inquiry (*e.g.* experiments or surveys) to investigate variables and selects instruments that yield statistical data.

The most 'rigorous' form of quantitative research follows from a test of a theory and the specification of research questions or hypotheses that are included in the theory (Creswell 2003). These research questions and hypotheses are in most cases based on the theories the researcher seeks to test. Viewing a theory as an explanation can account why a theory may be defined as a 'set of interrelated constructs (variables), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the

[13] Non-experimental research is almost the same as experimental research; the only difference is that it does not involve a manipulation of a situation, circumstances, or experience of the participants.

purpose of explaining natural phenomena' (Kerlinger 1979: 64). In this definition, a theory is a set of interrelated constructs that are formed into propositions/hypotheses that specify the relationship between variables. As a result, the aim of quantitative research is to explain or predict phenomena that take place rather than develop a theory, which is the aim of qualitative approach. Therefore, the purpose of quantitative research is to test or verify a theory through several steps such as to advance a theory, collect data to test it, and reflect on the confirmation or disconfirmation of the theory by the results (Creswell 2003). This deductive model of thinking is presented in Figure 9.

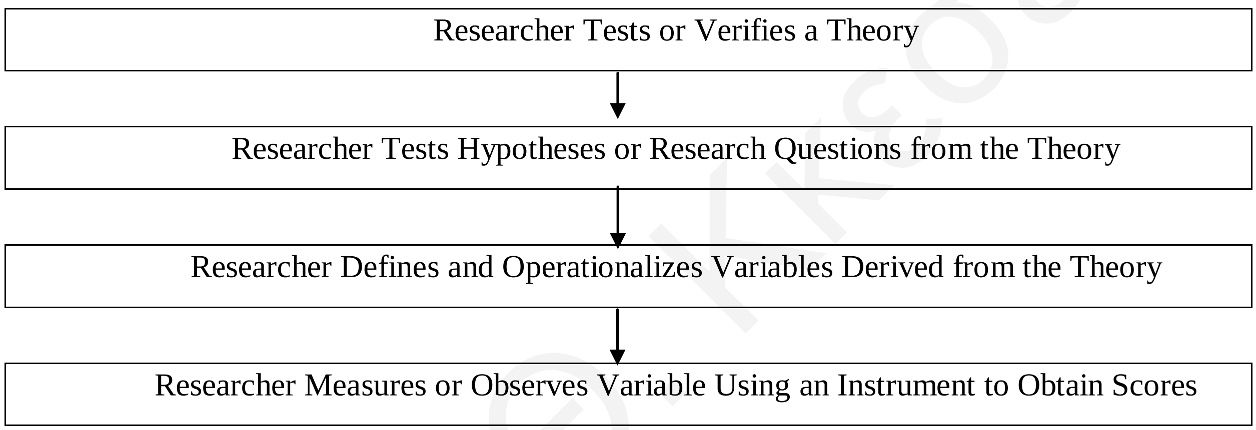

Figure 9: The deductive approach typically used in quantitative research (adapted from Creswell 2003: 125)

Consequently, for Research Questions 1 and 2, quantitative, numeric data was collected using the auditory tasks emphasising on the identification of L2 English plosive consonants. The aim of was to identify the potential factors affecting the identification of plosives as well as the types of errors produced by the participants regarding plosives. After the data collection was completed, the data was statistically analysed to examine any possible relations between the dependent and independent variables (percentage of correctness and five factors respectively) as manifested in the two tasks as well as the types of errors produced involving plosives for the second task. The aim was to test the two approaches (second language phonology and speech perception) with the purpose of explaining which one is responsible for the CG users' difficulties with L2 plosives.

The visual model of the quantitative procedures of this study is represented in Figure 10. The results of the two tasks are integrated during the discussion of the results of the whole study that attempts to identify the source of L2 difficulties and whether these are the result of second language phonology or speech perception.

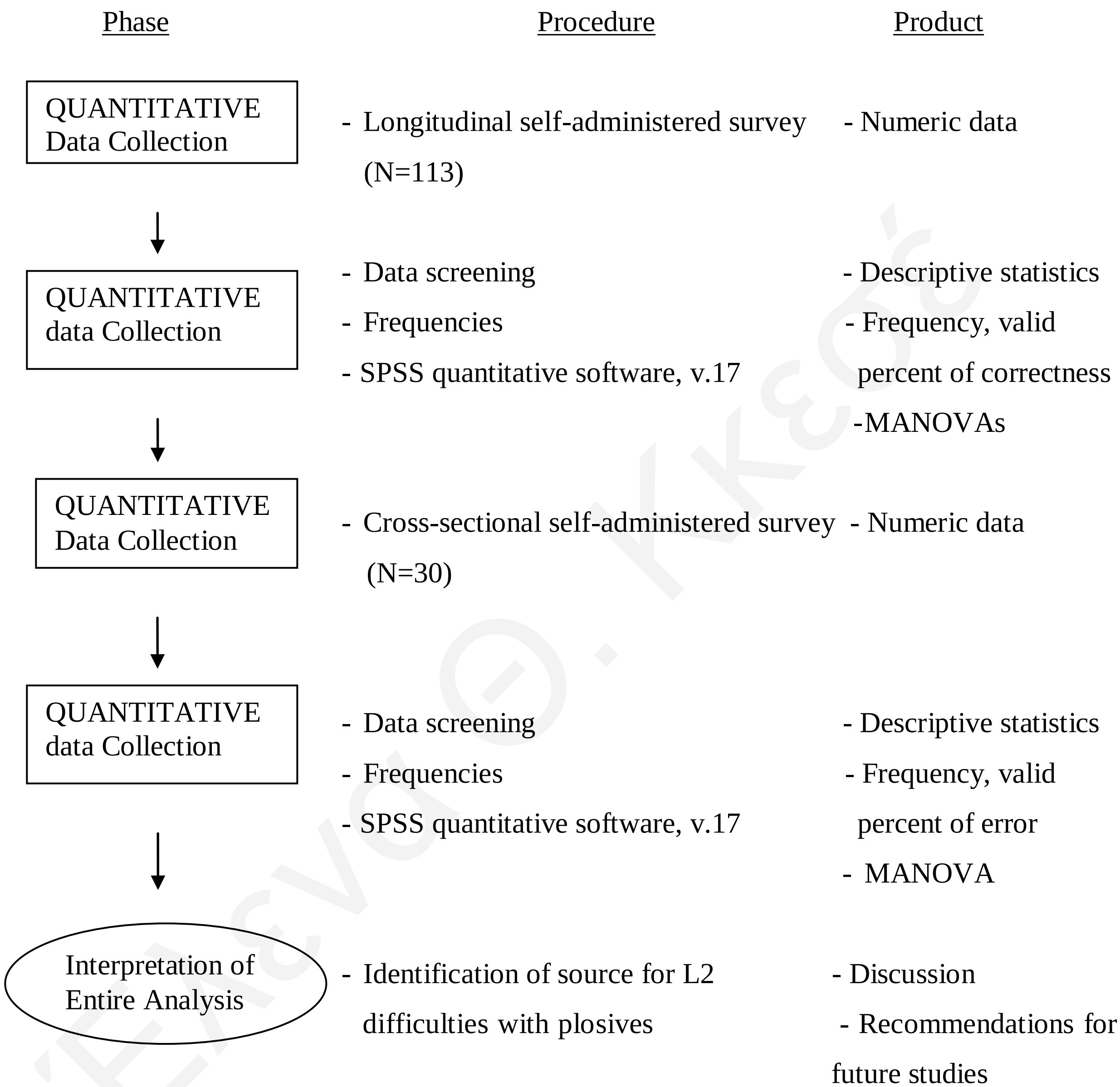

Figure 10: Visual model for quantitative procedures

Regarding the two tasks designed to obtain data for the study, similar tasks have widely been used in L2 studies (Rogers 1997).

2.1. Identification tasks

The presence of minimal pairs (Hyman 1975) in a language seems to provide evidence for the existence of phonemic contrast in the language under question. Specifically, Trubetzkoy's (1958/1969) second rule for determining phonemic status suggests that '[i]f two sounds occur in exactly the same position and cannot be interchanged without a change in meaning of the words or without rendering the words unrecognizable, the two sounds are phonetic realizations of two different phonemes' (48). Consequently, a minimal pair of words involves 'two words of distinct meaning which exhibit different segments at one point but identical segments at all other points. The existence of such a pair demonstrates conclusively that the two segments which are different must belong to different phonemes' (Trask 1996: 224). Minimal pairs[14] in English are evident in words such as *pillow-billow, trudge-drudge,* and *croup-group* in which the plosives /p b t d k g/ represent different phonemes in the language's phonemic inventory.

Minimal pairs have commonly been used in descriptive linguistics for ascertaining the phonemic inventories of developed languages (Hockett 1955), clinical studies (Ansel & Kent 1992, Kent et al. 1989, Boothroyd 1985, Monsen 1981), and L2 studies (Rogers 1997) to establish distributional properties of phonemes and the nature of the contrasts. In clinical and L2 studies, minimal pairs normally entail testing intelligibility (Chin & Finnegan 1998). Participants are asked to listen to a spoken stimulus that includes the target word and at least another word (a minimal pair), or more words (a minimal set or a set of minimal pairs) and select what they hear from the response set that may involve orthographic or pictoral representations. In Kent et al.'s study (1989), the response sets consisted of four words, namely the target words and three other words that formed a minimal pair with the target word. An example included the words *bad* that was the target word, *bed* that focused on vowel contrast, *bat* that emphasised on final voicing contrast, and *pad* that concentrated on initial voicing contrast. According to Kent et al., these words should reflect the potential speech production errors observed among the participants. Rogers (1997) following this approach conducted a test in which words were based on phonetically transcribed errors observed in a group of Mandarin speakers of L2 English (Rogers, Dalby & DeVane 1994) but the response set in the study involved minimal pairs such as *frog-fog*. In Monsen's study (1981), sets of minimal pairs such as *bit-but-bid-bud* and minimal sets such as *look-luck-lack-lock* were used.

[14] The minimal pairs used as examples in this chapter (*e.g.* words and/or sentences) are taken from the actual tasks developed for the purposes of the present study.

Regardless of the procedure followed, though, minimal pairs seem to constitute a reliable means of the existence of phonemic contrast and provide an insight into L2 users' ability to identify consonant contrasts in the context of real-words.

Recognising words in sentences constitutes a further way to assess listeners' identification skills that depends on linguistic context and metalinguistic skills. This dynamic exchange of information and use of context and environment (*e.g.* relationship between preceding and target utterance) are important for daily communication. However, in an effort to control these effects, identification tasks were developed in which unrelated lists of sentences were used instead. In such tasks, the conditions are held constant, each sentence is heard only one time, the listener's ability differs because of perceptual ability, and responses are scored as percent correct (Erber 1988). As a result, these testing conditions are reliable and easily standardised enabling the comparison and replication of procedures.

3. Materials

3.1. Stimuli

A total of 120 target items for the first task and 72 target items for the second task were compiled that were arranged in minimal pairs focusing on plosive consonants. These words had similar phonetic structure differing only in consonant voicing (Table 6). Specifically, in each pair the two sounds in question could be contrasted word-initially, -medially, or -finally. Lexical stress could not aid the recognition of phonetically similar words either, since the stress was falling on the same syllable for both words within the pair. Overall, the words used for both tasks could have one up to four syllables.

Low-frequency words were preferred since these, unlike the words of high frequency, cannot be identified on the basis of fewer perceptual features. Therefore, participants could not predict the target word that easily. Nonetheless, even though the English spelling is often not isomorphic to pronunciation, the words used had a transparent spelling. Only a small subset consisting of 5 pairs of words[15] was appearing in both tasks while the rest of the individual stimulus items were distinct for the two tasks. Both tasks were pre-recorded using Audacity 1.3 Beta software for recording and editing sounds and were saved as separate .wav files. The speaker (one woman, age 30) was a native RP (Received Pronunciation) speaker. She read the words and sentences comprising the two tasks from a printed list while speaking into a

[15] The 5 pairs of words included the words *disperse-disburse, broke-brogue, clamorous-glamorous, crack-crag,* and the distractors *loath-loathe*.

microphone that fed directly into the sound card (IDT High Definition Audio CODEC) of a laptop computer. The speaker was told to read at her normal pace without any particular attention to clarity and to imagine that the intended listeners were highly familiar with her voice and speech patterns (conversational speaking style). The reason why the speaker was the same for the two tasks was to avoid the great variety that may have been caused by using different speakers.

Category	**Contrast**	**Minimal Pairs**
Voicing	Bilabial voiceless vs. Bilabial voiced	pacing – basing calipers - calibers tripe-tribe
	Alveolar voiceless vs. Alveolar voiced	towering – dowering sighting – siding squat - squad
	Velar voiceless vs. Velar voiced	crammer – grammar lacquered – laggard broke - brogue

Table 6: Minimal pairs test items

3.1.1. Word identification task

The objective of this auditory task (see Appendix B and C pp. 207-210 for complete list and instructions given to participants – key words are underlined) was to examine the identification of plosives with special emphasis on the voiceless and voiced bilabial /p b/, alveolar /t d/, and velar /k g/. This word identification task was administered as a two-alternative forced-choice task with a circling response mode. On each trial, participants listened to a target word and its foil and responded by circling the word they had heard. Responses were scored as correct or incorrect generating an overall percent correct score as well as percent correct scores for the feature classes consonant voicing, place of articulation, word position, and syllable position.

The task consisted of 120 words that were arranged in 60 pairs and participants had the opportunity to listen to the words for two times while response order and stimulus were counterbalanced. Each pair of words was parallel in distribution and semantically contrastive differing in only one sound that could be found word-initially, -medially, or -finally. 16 minimal pairs were included for each category, namely for the voiceless/voiced bilabial /p b/, the alveolar /t d/, and the velar /k g/ while distractors focusing on the voicing contrast were also intermixed and made up 12 of the minimal pair words. Specifically, 2 to 4 distractors were used for every 16 presentations. These included fricative consonants such as the labiodental [f] and [v], dental [θ] and [ð], and alveolar [s] and [z], while some involved the palato-alveolar affricate consonants [ʧ] and [ʤ]. The words were presented in two fully randomised blocks in order to exclude any systematic patterning. Two versions of this task were created for the different groups of participants containing the same list of words but in which the selection of items was entirely complementary. This type of task was chosen to eliminate any semantic information from the input (context-free) as it may have occurred if a conversation was presented instead.

3.1.2. Words-in-sentences identification task

The second auditory task (see Appendix D pp. 211-212 for complete list and instructions given to participants – key words are underlined) consisted of 36 unconnected declarative sentences ranging in length from 7 to 30 words and involved minimal pairs with the plosives /p b t d k g/. 10 minimal pairs were included for each category, namely for the voiceless/voiced bilabial, alveolar, and velar categories. These were randomised while every after 10 presentations, 2 distractors followed. Distractors also emphasised on the voicing contrast and comprised 6 of the sentences involving fricative consonants, such as the labiodental /f v/, dental /θ ð, alveolar /s z/, and postalveolar /ʃ ʒ/ as well as the palato-alveolar affricate consonants /ʧ ʤ/. In each sentence, the two words comprising the minimal pair were removed and were replaced by dash. Participants had to listen to the complete sentences and fill in the blanks with the words they thought they heard. In this task, just like the word identification task, special attention was drawn to the voicing contrast, place of articulation, word position, and syllable position. Nonetheless, the significance of word position involving the plosive consonant in the utterance was also taken into consideration. Even though using unrelated lists of sentences aims at eliminating the use of linguistic context and environmental cues, still sentential context (syntax and semantics) is available to assist participants in identifying the correct words or type of words based on what could make sense in the blanks constructing meaning from the test itself.

As with the word identification task, responses on the words-in-sentences identification task were scored as correct or incorrect generating an overall percent correct score, as well as percent correct scores for consonant voicing, place of articulation, word position, syllable position, and word in utterances.

3.1.3. Questionnaire

Relevant information on participants' background for the study was collected via a questionnaire designed for the purpose (see Appendix E pp. 213-214) that was written in the L2 while special attention was drawn to question wording and content, response format, and the sequence of questions. The questionnaire consisted of three sections including dichotomous closed-ended questions while in some cases, certain questions had an open-ended 'Other (specify)' option. Specifically, section A elicited personal information about the participants (6 questions and 3 sub-questions). Section B elicited information regarding their educational background (2 questions and 2 sub-questions). Section C elicited information regarding the participants' English language proficiency and usage (2 questions and 4 sub-questions). The questions were designed to be short, simple, and comprehensible, avoiding ambiguous and vague questions.

4. Participants

CG users of L2 English with normal speech and hearing were recruited for the purpose of this study. In order to ensure a homogenous participant pool, the participants were active undergraduate students in a private English-speaking college in Larnaca, Cyprus, specialising in the areas of Business Administration and Computing. In that way, participants shared the same characteristics (*e.g.* educational level, socio-economic status) since the aim was to eliminate inter-group differences.

The majority of the participants consisted of first-year students in their second semester who had already attended a foundation course in the target language as well as an introductory English course (ENG 101), and who were currently enrolled in an English composition writing course (ENG 102). Concerning the rest of their college courses, these were also taught in English while both the introductory English and composition writing courses were taught by the researcher. Non-probability convenience sampling was therefore used since participants were selected based on their availability to the researcher due to access, time, resource, and financial constraints. The only cases involving students of different years had to do with the fact that some older students had failed the course in the first year and had to repeat it later on.

The participants were chosen so as to get a better understanding of how successful learners are able to become for a given task. Choosing less advanced students may have yielded more L1 influence in general, however, it would not have been clear if they could overcome this influence and become sensitive to the L2 segments that may not be present or may be noncontrastive in their L1. Further, it was crucial that the participants fully understood the instructions for both tasks. Participation in the two tasks was on a completely voluntary basis and participants were ensured about the confidentiality of their personal detail.

ENG 101: Students were already familiar with recorded tasks since listening and reading constituted the two major components of the introductory course ENG 101 during their first semester of studies (fall semester). That course had two main purposes. First, it aimed at enhancing the English proficiency of students through the General English component emphasising on listening and reading skills. Second, it was introducing them to the basics of English academic writing through the Academic Writing component emphasising on advancing their written expression and research skills. Listening was also the first part of the midterm examination of that course. Generally, the listening module of ENG 101 was based on the IELTS listening test designed to reflect real-world listening situations. The question types differed and focused on a variety of different linguistic skills including completing a form, chart, diagram, or some notes, as well as multiple-choice questions. Different type of language and context were characteristic of the four different sections of the test involving a conversation between two speakers in a social or semi-official context, a talk by a single speaker based on a non-academic situation, a conversation with up to four speakers based on academic topics or course-related situations, and a university-style lecture or talk. In that way, the module aimed at improving the students' overall listening strategies (Kkese 2008).

ENG 102: This course continued the process begun in ENG 101 of assisting students advance their writing and research skills. The main purpose of the course was to enable students to become independent thinkers, readers, writers, and editors by expanding their reading and writing skills acquired during the previous semester and applying them to selected assignments throughout the course. Based on the premise that clear thinking generates clear writing, students were required to learn how to think more clearly, organise thoughts in logical sequence, and improve writing skills through prewriting, writing, and rewriting processes. Grammar, usage, spelling, and punctuation were also a key component for this course. Further, emphasis was placed on the elements that constitute various rhetorical writing patterns and on developing skills in writing essays in these patterns. Consequently, through constant practice of these skills, students were becoming aware that good written expression draws upon a wide array of underlying component abilities (Kkese 2009).

Overall, the number of students who took part in the study was 113 and involved students of three different years due to the longitudinal design of the study. In particular, during the first spring semester, participants consisted of 37 students, in the second spring semester participants were 46, and in the third spring semester participants were 30 students. Some students could have been in the sample more than once since they had failed the class and had to repeat it. Nonetheless, since a long time period had passed (one or even two years), this suggests that there was no learning effect. The only cases in which participants were excluded from the sample involved students whose L1 was not the CG due to the study's emphasis. Students in each semester were divided into three groups due to the nature of the course, which involved working with a small number of students. These groups consisted of two full-time and one part-time group. Nonetheless, since intergroup differences are not the primary concern of this study, the different groups of each year were dealt as only one group.

First semester students

In the first spring semester, 61 students were attending the composition writing course ENG 102 out of whom only 9 were in the Business Computing programme and these were all part of one group. In the study, though, only 37 students participated. These involved 33 full-timers and 4 part-timers out of whom 31 were attending the Business Administration programme and 6 the Business Computing programme. The rest were either absent or had withdrawn while one female student was excluded since she was not a CG speaker. Concerning the part-time group, this consisted of students who were either second-year students repeating the course or older people who decided to attend college for personal or job-related reasons (*esp.* obtaining a better job, gaining a promotion) and were in their second semester. All the participants' L1 was CG while their ages were between 18 and 26.

Second semester students

The three groups consisted of 58 students out of whom 42 were attending the full-time mode of studies and 16 were part-timers. Only 5 students were attending the Business Computing programme. 46 students participated in the study since 10 were absent on the data collection day while 2 female students were excluded since their L1 was not CG. Therefore, from the 46 participants, 44 were attending the Business Administration programme and 3 the Business Computing programme. These students' L1 was CG while their ages ranged between 18 and 26.

Third semester students

In the spring semester of 2011, 34 students were registered for ENG 102. 30 of these students were attending the morning classes and 4 were attending the afternoon/evening classes offered for part-timers. Only 3 of the 34 students were attending the Business Computing programme. Out of these 34 students, only 30 took part in the study since 3 were absent on that day while one female student was excluded due to her L1, which was not the CG. More specifically, among the participants there were 28 students attending the Business Administration programme and 2 attending the Business Computing. CG was the L1 of all the participants even though 2 participants had an English-speaking parent. The students' age range was from 18 to 26 years old.

5. Procedure

The research period involved three spring semesters (longitudinal design employed) with data being collected during the spring semesters of 2009, 2010, and 2011. The reason was to investigate whether different students of the same level (introductory first year students) and the same background (CG users of L2 English) face the same difficulties with the specific sounds under investigation that would not be possible if the research period only involved one semester. Each of the investigated semester lasted for fifteen weeks (January-May) out of which thirteen weeks were dedicated to classes and the rest for examinations. Concerning the data collection, this took place toward the end of the semester in all three years (weeks 12 and 13) in one of the ENG 102 teaching sessions. A teaching period lasted for 50 minutes for the full-time students but in Fall 2010 this changed to 55 minutes. Each group met 5 times a week for the specific course. Concerning the part-time students, these were taught only once a week while their class was scheduled for two and a half hours with a fifteen minutes' break.

Both full- and part-time students were asked to perform the tasks in the convenient and familiar environment of their classroom at the presence of their lecturer who was also the researcher of this study. The researcher's presence made sure that students could seek clarity on any question as to meet consistent question objectives (Aaker, Kumar & George 2000, Sekaran 2000), students were more motivated to undertake the tasks since they were not forced to admit their confusion or ignorance to the researcher (Burns & Bush 2002, Sekaran 2000), the tasks were collected immediately upon completion ensuring a high response rate of almost 100% (Sekaran 2000, Maalhotra 1999), anonymity was ensured since students were not required to disclose their identities (Burns & Bush 2002, Sekaran 2000), while this method offered highest degree of control over sample selection (Burns & Bush 2002, Malhotra 1999).

During the first two semesters only the word identification task was used. After the distribution of the task, students were asked to go over it and circle the word that they thought they heard in each minimal pair while they had the opportunity to hear the recorded task twice. No participant judged the sound level as uncomfortable while in order to avoid confusion, the number of pairs was also included in the presentation of stimuli. Between the pairs there was a 2-3 seconds time interval and additional instructions to the task were also given in CG.

In the third semester, though, both the word identification task and the words-in-sentences identification task were distributed. Concerning the latter, this was developed afterward in order to investigate the effects of word position in an utterance. Having the same participants undertaking the two tasks allowed a reliable comparison of L2 users' performance for both the word identification and words-in-sentences identification tasks. Before the actual tests, however, students had to answer the questionnaire regarding their background that was used to present demographic data about the participants as well as their L2 learning background and use of L2 English in their daily life. This was developed and distributed only during the spring semester of 2011. The questions included in the questionnaire were read aloud by the researcher in both English and CG. After completing the questionnaire, students had to listen to the word identification task and then to the words-in-sentences identification task. Between the tasks, there was a ten minutes' break allowing both the researcher to collect one task and distribute the next one and the students to relax before venturing into the new task. Concerning the former, the instructions were the same as the previous years while for the latter, students were asked to listen to the sentences and fill in the blanks with the missing information. The sentences were read using natural intonation with approximately a 2-3 seconds time interval between them. Students after listening to the sentences once had the opportunity to listen to them for a second time to fill in any missing words that they were left blank during the first listening. Instructions were given in CG for all steps involved in the data collection.

Spring semester 2009: the data collection for the word identification task took place during week 13 (middle of May) for the full-time groups. Group A had to listen to the first version of the task while Group B had to listen to the second version. The part-timers also listened to the second version of the task with the only difference that this happened during week 14 (middle of May). Generally, 37 word identification tasks were collected.

Spring semester 2010: the data collection task took place in three different sessions for the groups during week 13 (middle of May). Both Group A and the part-timers listened to the first version of the word identification task while Group B listened to the second version. The number of tasks collected was 46.

Spring semester 2011: students were first required to fill out the background questionnaire while concerning the word identification task, the part-timers and Group A listened to the first version and Group B listened to its second version. Regarding the words-in-sentences identification task, students had to listen to the same version. The data collection occurred during week 12 (middle of May) in different sessions for each group and overall 30 questionnaires, word identification tasks, and words-in-sentences identification tasks were collected.

6. Data analysis strategy

After the questionnaires and tasks were turned in and numbered (given an ID number in the top right corner), the researcher could start the data analysis. Steps such as coding the participants' responses, cleaning, screening the data, as well as choosing the appropriate data analysis strategy comprised the data analysis process (Churchill & Iacobucci 2004, Sekaran 2000, Malhotra 1999, Luck & Rubin 1987) as detailed below.

6.1. Coding of responses

For this first step, the researcher had to score the written responses of the participants to the two tasks as 'correct' or 'incorrect'. In order for a response to be correct, it had to match the stimulus test word. Upon completion, 'correct' and 'incorrect' were converted to numbers so that data could be entered into the statistical analysis software package SPSS, version 17.0 (Statistical Package for Social Sciences) for the next steps. Specifically, for the Research Question 1 'correct' was coded as 1 and 'incorrect' as 0, in which 0 meant 'not correct'. This is called dummy coding and is useful for using the data in some types of analysis and for obtaining descriptive statistics. For instance, the mean of data coded this way could give the percentage of answers that fall in the category coded as 1. For Research Question 2, the data obtained for the second task was first entered on an SPSS spreadsheet as string variables in order to have the exact words elicited by the participants that would enable a comparison of the responses while the researcher would be able to identify and categorise errors made by the participants. Then, another SPSS spreadsheet was created in which 'correct' was coded as 0 while there were six incorrect responses coded from 1-6. Participants' responses on the background questionnaire were also coded but both numeric and string variables were used for that purpose.

6.2. Cleaning and screening data

This refers to inconsistency checks and missing responses (Malhotra 1999, Luck & Rubin 1987). Cleaning and screening of the data sets involved an examination of basic descriptive statistics and frequency distributions. Values that were inappropriate coded or were out of range were identified with straightforward checks (Kassim 2001). A frequency test was run for every variable to identify valid percentage for responses and locate any illegal or missing responses.

6.3. Selecting a data analysis strategy

In order to choose the suitable statistical analysis technique, the research elements such as the research problem, hypotheses/questions, characteristics of data, and underlying properties of the statistical techniques were taken into account (Malhotra 1999). For the purposes of this study, thus, both descriptive and inferential analyses were applied.

Descriptive analysis

In this way, raw data were transformed into a form that could provide information to describe a set of factors in a situation and make them easy to understand and interpret (Kassim 2001, Sekaran 2000, Zikmund 2000). Therefore, after the data was coded, the total number of correct/incorrect responses was counted for each case and this data was entered on a new SPSS spreadsheet. A different SPSS spreadsheet was created for each of the investigated factors (a)-(d) while for the types of errors one SPSS spreadsheet was created. These were used to compute frequency distribution, mean, and standard deviation that helped giving meaning to data and identifying differences among the two tasks with reference to the investigated factors (a)-(d), factor (e) that was present only for the second task, and types of errors. The same procedure was followed for the questionnaire's responses. Descriptive statistics were also used for the first section of the results aiming at establishing the participants' level of English proficiency.

Inferential analysis

This refers to statistics that make inferences about population values based on the sample data that has been collected and analysed (Morgan et al. 2011). Inferential statistics used for this research involved parametric statistics and namely Multivariate Analysis of Variance (MANOVA). This statistical test was employed since there were many (hence multivariate) dependent variables in the research questions/hypotheses. A MANOVA is preferable to conducting multiple ANOVAs (a separate ANOVA for each dependent variable) for various reasons. Firstly, by conducting multiple ANOVAs there is a great chance of making Type I error since the more tests are conducted on the same data, the more the familywise error rate is inflated. Secondly, MANOVA by including all dependent variables in the same analysis takes account of the relationship between outcome variables. These relationships between dependent variables are ignored in ANOVA that can only inform about whether groups differ along a single dimension. As a result, by conducting a MANOVA several dependent variables can be looked at simultaneously in an effort to come up with the most important factors that affect the identification of plosive consonants for CG users of L2 English.

6.4. Reliability and validity

In quantitative research, reliability and validity of the instruments help decreasing errors that may result from measurement problems in the research study. The former refers to accuracy and precision of a measurement procedure while the latter involves the degree to which a study accurately reflects or assesses the concept or construct that the study aims at measuring (Thorndike 1997).

Reliability of the instruments was obtained through a small pilot testing (2-3 people) aiming at providing information on which items (words, sentences, or even instructions) needed rewording or even removal from the tasks. Validity was established through an examination of the tasks by three university professors (dissertation supervisory committee). This helped assess whether the wording and tasks seemed relevant to the subject they aimed at measuring, if they were reasonable ways to gain the needed information, and if they were well-designed.

7. Ethical considerations

During data collection as well as in data analysis and interpretation, several issues emerge that call for good ethical decisions. The first issue involves the right to participate voluntarily in the study and the right to withdraw at any time. Participants in the study were informed about this right and the fact that the tasks and procedure were not a test for the specific course or for other purpose that would have an impact on their final ENG 102 grade or performance in general at the college. The procedures of the study were also announced to participants in order to know what to anticipate in the research. Further, they were informed that they could ask questions if desired and that their personal information would not be revealed. Their responses would be reported anonymously since each task would numerically be coded. In that way, the researcher also aimed at making students feel more at ease to accomplish the tasks that were developed.

Students were told the general purpose of the study, namely, that it aimed at examining participants' degree of consonant identification in L2 English. It was only after the completion of the tasks, though, that the researcher asked about students' understanding of English plosive consonants making a reference to the voicing contrast and how they pronounce voiceless and voiced words by providing examples. The reason why the researcher did not reveal the exact purpose of the study beforehand was to avoid biasing the participants into thinking only in terms of one feature class (*e.g.* voicing). Finally, the participants were reassured that data, once analysed, would be kept for a reasonable time (Sieber 1998) and it would then be destroyed.

Summary

In this chapter, the methodology of the present study is presented in detail. Specifically, this chapter provided a careful description of the research design employed for this quantitative study and introduced the research questions and hypotheses that were formulated as the result of the understanding of the approaches and previous studies as these were presented in Chapter two. Further, it described the process taken in the administration of the tasks and provided an introduction to the data analysis of this quantitative approach employed for the study. In the following chapter, the results of the data analysis are presented with reference to the two research questions.

CHAPTER FOUR: RESULTS

Introduction

This chapter presents the results of the data analyses of both the descriptive and inferential analyses used in this study (the outputs from SPSS are listed in Appendix F pp.215-274). Section One begins with the description of the participants who were excluded from the analysis before turning to the discussion of the results. Further, background information is provided regarding the participants' English proficiency level in an effort to document the homogeneity of the group. Section Two addresses the first research question aiming at identifying the factors that affect the identification of plosive consonants by CG users of L2 English as these have resulted from the theoretical inquiry (see Ch.2 Section 3 3.1-3.5) and were discussed in detail in the methodology chapter (see Ch.3 section 1). In answering this question, the quantitative data collected from the two identification tasks (Word identification task and Words-in-Sentences identification task) is used while it is also determined what factor(s) are the most important influencing the identification of plosives. Once the factors are identified (Research Question 1), the next step is to investigate how participants try to cope with these difficulties and which are the strategies they adopt (Research Question 2). As a result, section Three addresses the second research question examining the participants' types of perception errors concerning plosive consonants though the quantitative data collected from the second task.

Results for the first section are presented with the aid of descriptive statistics including graphical summaries, such as histograms that illustrate the overall data pattern. For the second and third sections, the data used is first transformed into percentages in order to be normalised before it is analysed while the results are presented with the aid of descriptive statistics, mainly frequency tables, as well as inferential statistics, such as multivariate test statistics (MANOVA). A post-hoc comparison after Bonferroni adjustment is also performed in order to control the familywise error rate (a = .05).

1. *Demographics and Students' Background Data*

In this section, a detailed account for the exclusion criteria of the participants is provided and the data used for documenting the participants' level of proficiency in English is described. Histograms 12-14 indicate that the distribution of the data is normal and that there are no potential outliers. As a result, the majority of the students has an average performance suggesting that they are approximately at the same level. Specifically, the participants form a homogeneous group of introductory level students (not advanced students).

1.1. Participant Exclusion Criteria and English proficiency level

As it was mentioned in the previous chapter, 113 CG students of L2 English participated in the tasks even though data was collected from 119 students. The reason was that the participants were screened to ensure that CG was their L1 and that they were all of approximately the same level in terms of English proficiency with no learning disabilities. As a result, using these two criteria, five participants whose L1 was not CG and one participant who had learning difficulties were excluded from the final analysis since they did not qualify for inclusion in the final results. With reference to the participants, the majority were female students (64 out of the 113 participants).

In order to participate in the tasks, the students had to be currently enrolled in ENG 102 (Spring semesters of 2009, 2010, 2011) while they had to have attended ENG 101 (Fall semesters of 2008, 2009, 2010), which was an introductory English course. Both courses were taught by the researcher in order to ensure the participants' L2 proficiency a priori based on their ENG 101 performance. The majority of the participants were first-year students (99 out of the 113) while the rest (14 students) were students of different years who were repeating ENG 102. Only some cases (18 students) involved students who had not attended ENG 101 before taking ENG 102 but these were new students who were registered in the spring semester and had the right to take courses offered during the semester they enrolled according to college policy. These students were included in the analysis after being evaluated on the basis of an oral interview by the college administration. As a consequence, it was determined that these students were of the same level as the rest of the first-year students.

In an effort to document the students' proficiency level in English, the total marks obtained in ENG 101 were taken into consideration. These marks were obtained by the 95 participants, who attended ENG 101 during the Fall semesters of 2008, 2009, and 2010 prior the research spring semesters. The total marks resulted from the marks received for the students' assignment(s), midterm examination, participation, coursework, and final examination. The histogram in Figure 11 indicates the frequency distribution of the total marks for ENG 101 since a histogram is a useful graphical tool in checking the normality assumption and in identifying potential outliers that deviate markedly from the rest of the data. Based on the histogram, the total marks for ENG 101 make up a random distribution having several modes (peaks). Nonetheless, this is probably due to the small sample size in the chart since normal trends usually appear with greater sample numbers. The histogram further indicates that no potential outliers were identified in the sample.

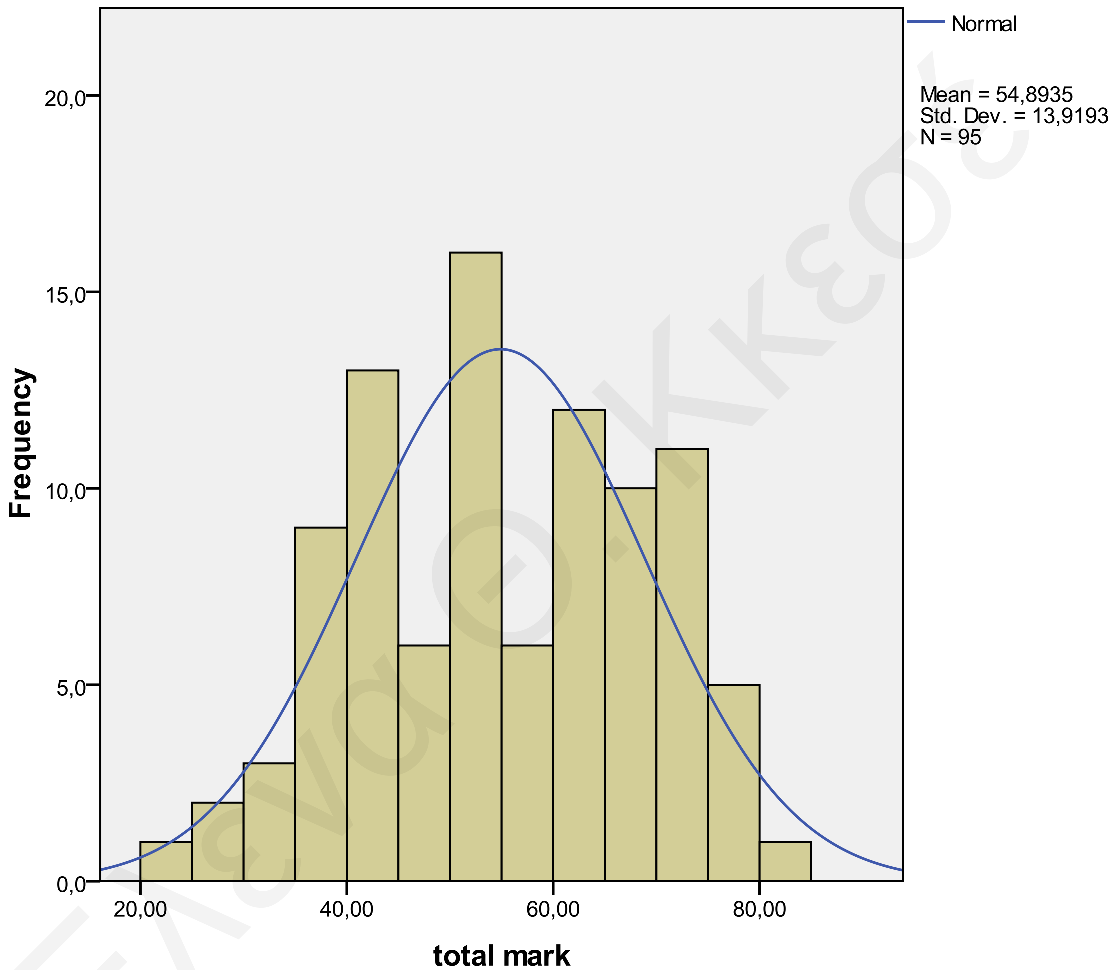

Figure 11: A grouped frequency distribution for total ENG 101 marks (no outliers identified)

1.1.1. 2009 and 2010 participants

Part of the midterm examination for ENG 101 (Fall semesters of 2008 and 2009) with reference to the first two spring research semesters was a listening test that could also function as a reliable indicator for the perceptual abilities of the students. This component of the midterm had a weighting of 30% while the other 70% was awarded for writing, which involved the second component of the examination. The listening test consisted mainly of gapfilling exercises and multiple-choice questions that was the pattern followed for the two developed tasks as already discussed in Chapter 3 in order for students to be familiar with such exercises. The weighted average obtained for the listening test was normalised so that it had a maximum of 100. The histograms in Figures 12 and 13 indicate the students' performance regarding the listening test for the Fall semesters of 2008 and 2009 respectively.

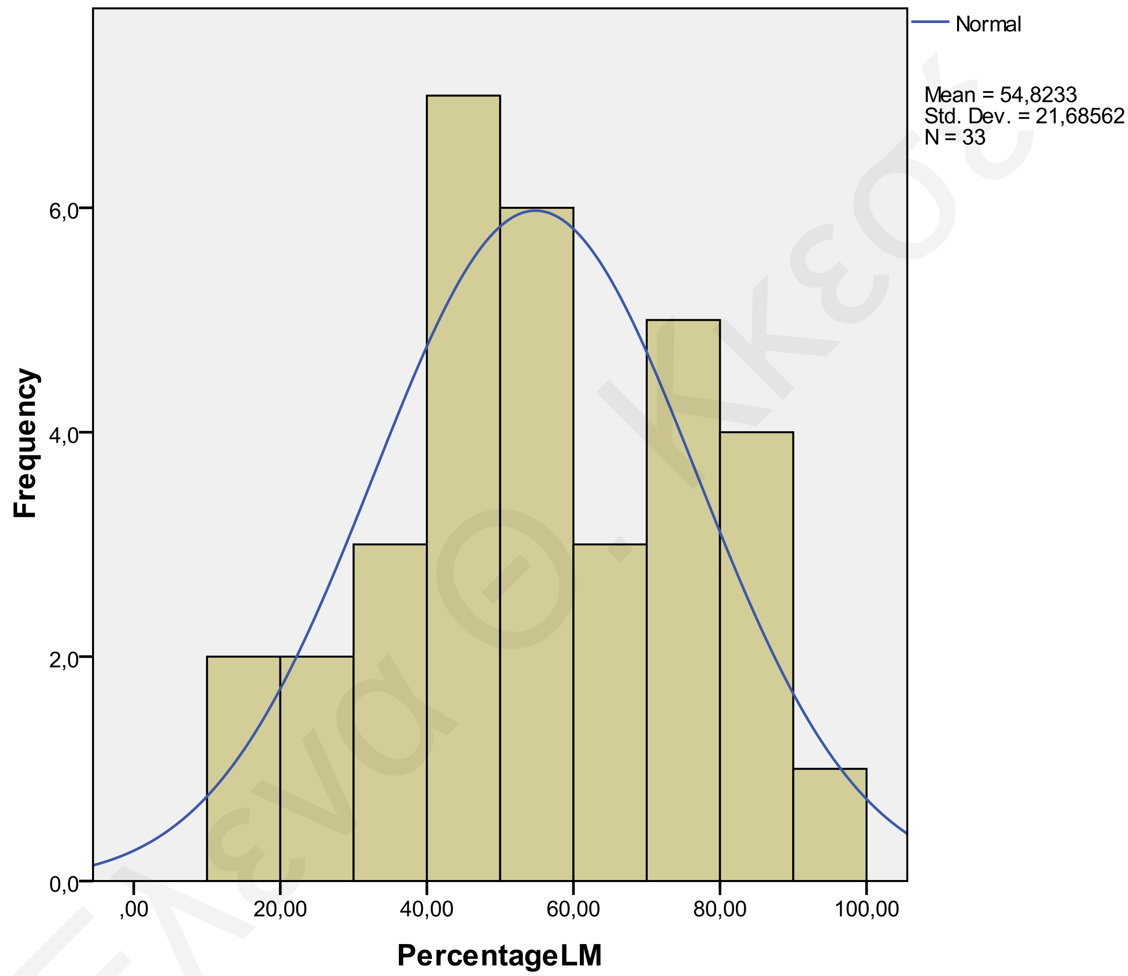

Figure 12: A grouped frequency distribution for the percentages of the 2008 listening midterm (no outliers identified)

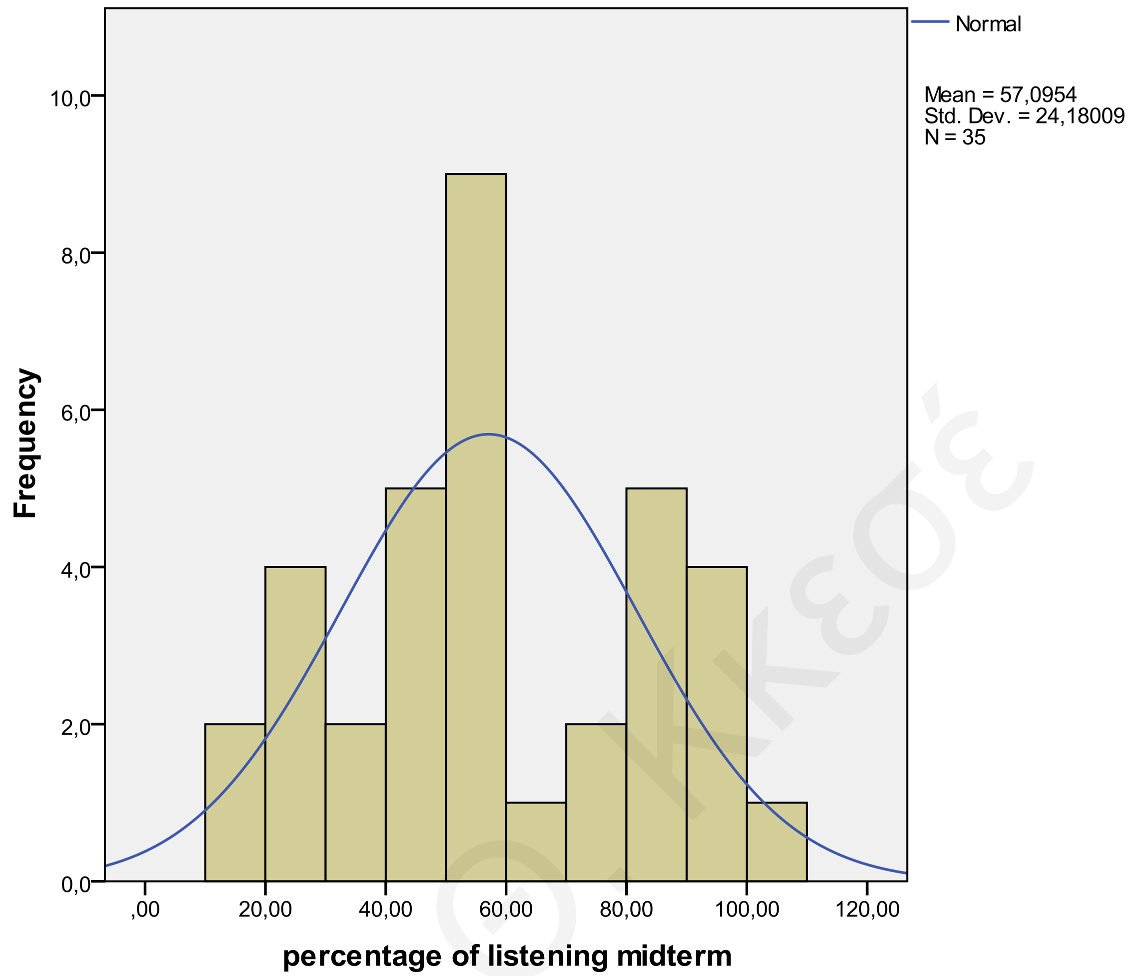

Figure 13: A grouped frequency distribution for the percentages of the 2009 listening midterm (no outliers identified)

These histograms appear to have two obvious relative modes or data peaks. This makes the data bimodal rather than being bell-shaped as it happens in normal distribution. However, given the small sample size in the histograms, a normal distribution would probably not to be expected since normal trends usually appear with greater sample numbers. Be as it may, the two histograms indicate that there are no obviously outlying points (outliers).

1.1.2. 2011 participants

Some changes in the syllabus for ENG 101 during the Fall semester of 2010 led to the exclusion of the listening test from the midterm examination in order to give more emphasis on the writing skill. Consequently, the only indicator for the students' English proficiency was their total ENG 101 mark (Figure 11). In an effort to overcome this difficulty, a questionnaire was designed by the researcher aiming at gathering information on the students' background including their English proficiency and usage. Table 7 summarises the factors that are usually thought to be relevant to the successful acquisition of the phonology, namely the amount of formal English instruction (reported in years), period of using English (reported in frequency), and use of English in everyday life (reported in contexts).

subjectid	YPL	FELU	CENSC	CNNSC	WC	HC	NRC	OC
1	7	1	0	0	1	0	0	0
2	4	5	1	0	0	0	0	0
3	4	5	1	0	0	0	0	0
4	4	4	1	0	0	0	0	1
5	4	5	1	0	0	0	0	0
6	4	5	0	0	1	0	0	0
7	3	5	1	1	0	0	0	0
8	6	1	1	0	0	0	0	0
9	5	5	0	0	0	1	0	0
10	4	5	0	0	0	0	1	0
11	4	5	1	0	0	0	0	0
12	4	5	0	0	0	0	1	0
13	7	4	1	1	0	0	0	0
14	5	5	1	0	0	0	0	0
15	8	5	1	1	0	0	0	0
16	5	5	0	0	1	0	0	0
17	8	5	0	0	1	0	0	0
18	4	5	0	0	1	0	0	0
19	8	4	0	0	1	0	0	1
20	8	5	1	1	1	0	0	0
21	9	1	1	1	1	0	0	0
22	8	4	1	1	0	0	0	0
23	2	4	1	1	0	0	0	0
24	8	5	1	1	0	0	0	0
25	8	4	0	1	1	0	0	0
26	8	4	1	1	1	0	0	0
27	6	4	1	1	0	0	0	0
28	8	5	1	0	1	0	0	0
29	8	5	0	1	0	0	0	0
30	7	1	1	1	0	1	0	0

Table 7: CG speaker Background, Ecological Factors

Key: YPL= Years of English Private Lessons, FELU= Frequency of English Language Use, CENSC = Communication with English Native Speakers Context, CNNSC = Communication with Non-Native Speakers Context, WC= Work Context, HC = Home Context, NRC = No Response Context, OC = Other Context

The above table illustrates that the speakers who took part in the study varied significantly in terms of years of formal private English instruction rather than frequency or contexts of speaking English in everyday life except the college setting. Nonetheless, the variation regarding the years of attending private lessons was expected. Histogram 14 indicates that the distribution is bimodal having two points of central location while there are no potential outliers in the data set. As already mentioned, given the small sample size in the histogram, a normal distribution would probably not to be expected. Concerning the frequency of using English outside the college, students reported using the language from sometimes to always (Sometimes=18, Often=8, Almost Always=4). Lastly, with reference to the contexts in which they use English, apart from two participants who did not respond, all the rest reported using the language in one, two, or three contexts out of the five possible contexts that were provided as options.

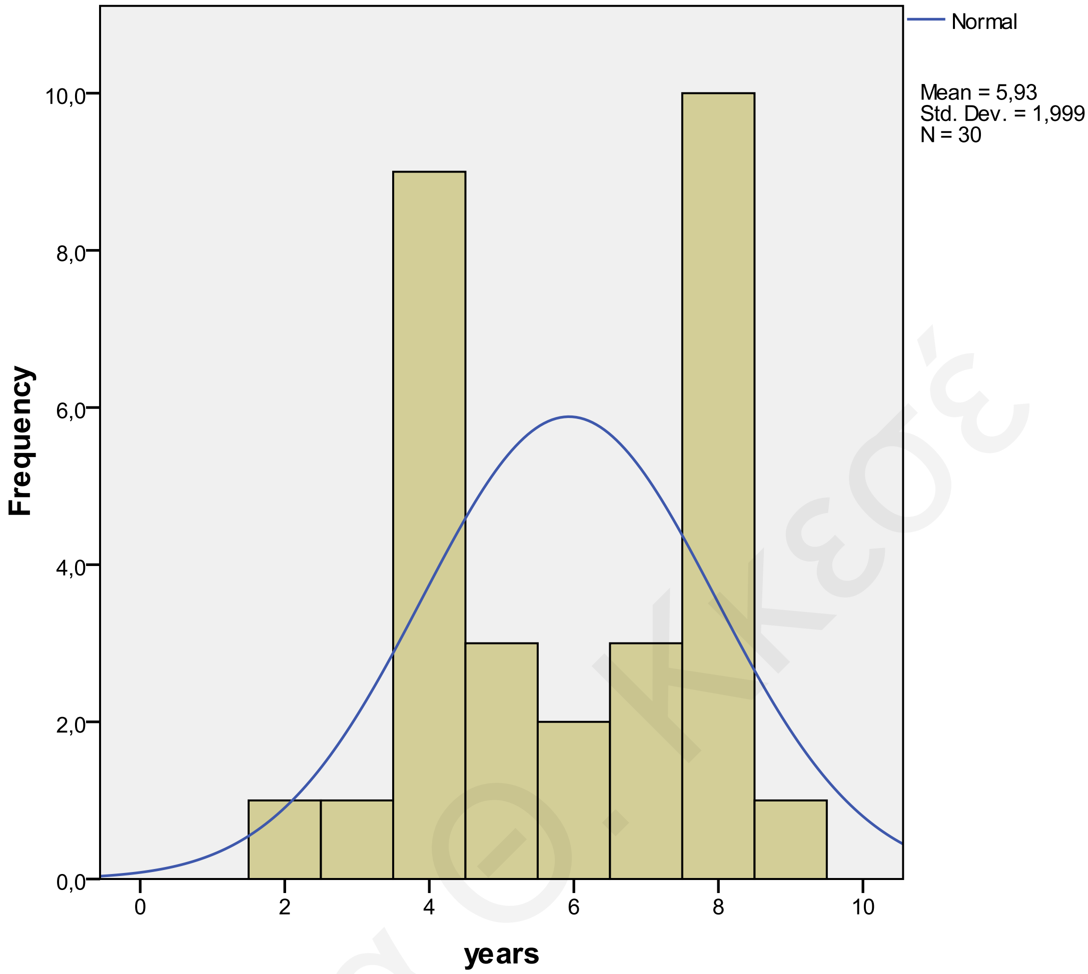

Figure 14: A grouped frequency distribution of YPL (no outliers identified)

2. Quantitative Results for Research Question 1

This section presents the results for Research Question 1: What are the factors that affect the identification of plosive consonants for CG users of L2 English? To answer this question, three Multivariate Analyses of Variance (MANOVAs) were performed for each task focusing on voicing and place of articulation, word position, and syllable position. MANOVA was used due to the presence of many dependent variables. For Task 2, descriptive statistics are provided for another factor, namely utterance position, but for this factor a MANOVA analysis could not be performed due to insufficient data.

2.1. Word Identification Task

To control for learning effects and order effects, two different formats of the Word Identification task (Task 1) were administered randomly to 113 students ($N = 113$) during the research period (Spring semesters 2009, 2010, 2011). In order to verify that the test format did not significantly affect performance, independent sample t-tests were conducted to compare mean performance overall. The performance indicated that there was not a significant difference between the two versions of Task 1, which were administered to the two groups ($p > .05$).

A Multivariate Analysis of Variance (MANOVA) with three articulation levels (bilabial, alveolar, velar) and two voicing levels (voiceless, voiced) as within subject factors was conducted in order to compare effects of voicing and place of articulation on performance. Two additional MANOVAs were conducted also including in each case word position (initial, medial, final), and syllable position (onset, coda) as a third within subjects factor. For all analyses, assumption of sphericity was checked using Mauchly's test. In case of sphericity violation, degrees of freedom were adjusted using Greenhouse-Geisser estimates of sphericity. To break down main and interaction effects, repeated contrasts were performed comparing the three articulation levels and the three word position levels.

The first MANOVA indicated a significant main effect of voicing on performance, $F(1,112) = 16.50$, $p < .001$, $\eta^2 = .13$ with overall performance (% correct answers) being higher for voiceless plosive consonants ($M = 56.33$, $SE = 2.15$) than voiced ($M = 49.85$, $SE = 1.90$). There were no significant main effects for place of articulation but the interaction between voicing X place of articulation was significant $F(2,224) = 7.28$, $p < .001$, $\eta^2 = .06$, such that participants performed considerably better in perceiving voiceless plosives only when place of articulation was bilabial (for [p] % correct $M = 58.41$, $SD = 28.66$; for [b] $M = 45.65$, $SD = 23.36$) or velar (for [k] % correct $M = 57.23$, $SD = 25.85$; for [g] $M = 50.57$, $SD = 25.27$) but not alveolar (for [t] % correct $M = 53.36$, $SD = 26.89$; for [d] $M = 53.33$, $SD = 26.03$). Specifically, there was an advantage of bilabial (voiceless $M = 58.41$, $SE = 2.70$; voiced $M = 45.65$, $SE = 2.20$) and velar plosives (voiceless $M = 57.23$, $SE = 2.43$; voiced $M = 50.57$, $SE = 2.38$) compared to alveolar (voiceless $M = 53.36$, $SE = 2.53$; voiced $M = 53.33$, $SE = 2.45$). The interaction is shown in Figure 15.

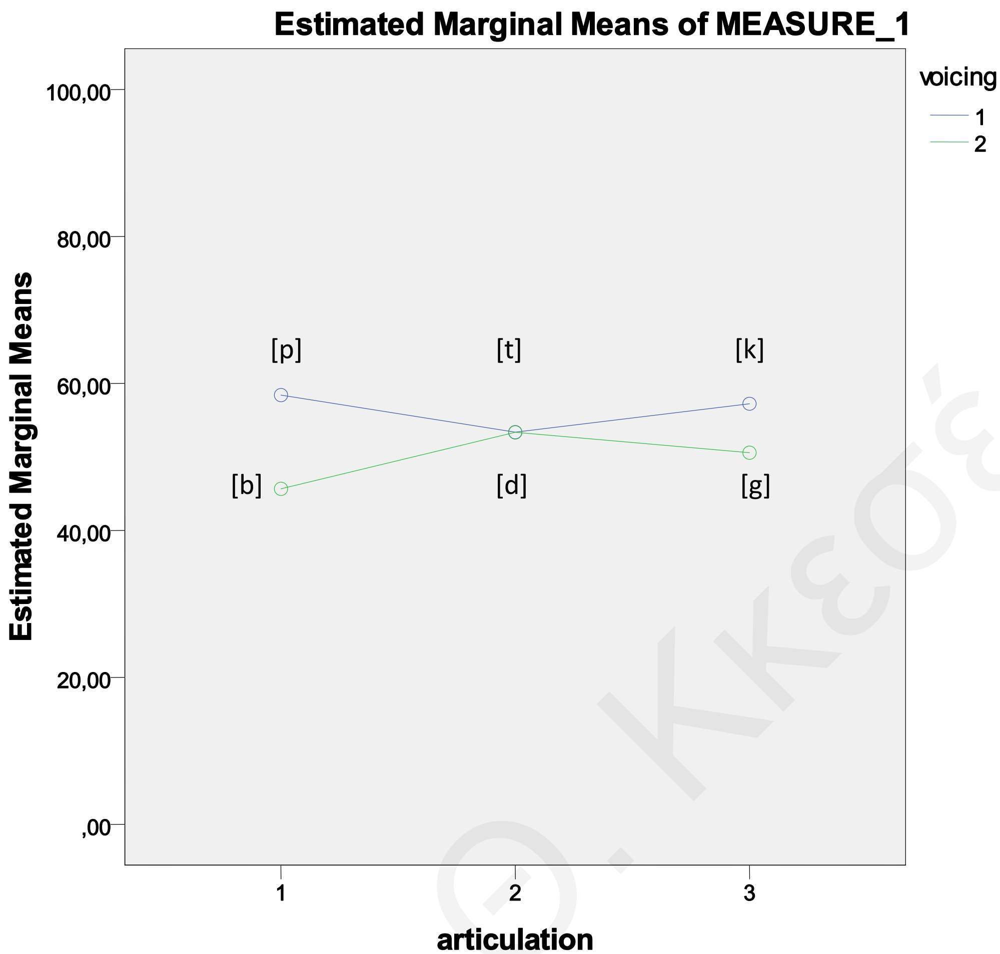

Figure 15: Interaction between voicing X place of articulation (better performance in bilabial and velar voiceless plosives)

The second MANOVA (voicing X place of articulation X word position) focused on word position as a function of place of articulation and voicing. Significant main effects for voicing (better performance for voiceless), $F(1,112) = 21.60$, $p < .001$, $\eta^2 = .16$ were maintained and an additional main effect for word position was identified, $F(1.8,202.46) = 13.54$, $p < .001$, $\eta^2 = .11$ (Greenhouse-Geisser corrected). For word position, the effect was significant for all three levels with best performance for initial word position ($M = 58.14$, $SE = 2.89$) compared to both medial ($M = 55.22$, $SE = 2.35$) and final ($M = 46.28$, $SE = 1.46$) and with best performance for medial word position compared to final. Especially, the advantage for voiceless ($M = 56.99$, $SE = 2.10$) over voiced plosives ($M = 49.44$, $SE = 1.95$) was greatest for final word position, less pronounced for initial word position, and absent for medial word position (Table 8). The interaction between word position X voicing was significant $F(2,224)$

= 18.46, p < .001, η^2 = .14. Specifically, participants performed significantly better in perceiving voiceless consonants in all three categories (word initial M = 59.64, SE = 3.01; word-medial M = 55.39, SE = 2.79; word-final M = 55.92, SE = 2.09) compared to their voiced counterparts (word initial M = 56.64, SE = 3.14; word-medial M = 55.05, SE = 2.55; word-final M = 36.63, SE = 2.01). Contrasts revealed that the percentage of correct responses was significantly higher for medial $F(1,112)$ = 14.43 and initial word position $F(1,112)$ = 19.31 compared to the final word position, ps < .001. However, effect of voicing (advantage for voiceless over voiced) was most pronounced for the word-final category (Figure 16). No other significant main effects or interactions were identified.

	word-initial	**word-medial**	**word-final**	**N**
	M(SD)	*M(SD)*	*M(SD)*	
PPVPAW				
Variable1:voiceless bilabial	59.82(42.47)	62.39(40.52)	54.72(35.18)	113
Variable2: voiceless alveolar	58.63(37.91)	51.03(35.79)	54.65(37.58)	113
Variable3: voiceless velar	60.47(38.84)	52.74(42.18)	58.41(34.08)	113
Variable4: voiced bilabial	52.74(41.06)	56.19(39.46)	34.81(33.45)	113
Variable5: voiced alveolar	56.86(40.12)	56.93(35.13)	38.50(38.53)	113
Variable6: voiced velar	60.32(40.78)	52.04(40.23)	36.58(34.42)	113

PPVPAW = Participants' Performance in terms of Voicing, Place of Articulation, and Word position

% correct

Table 8: Descriptive Statistics for performance of participants in terms of word position, voicing, and place of articulation (better performance in voiceless plosives in word-intial position).

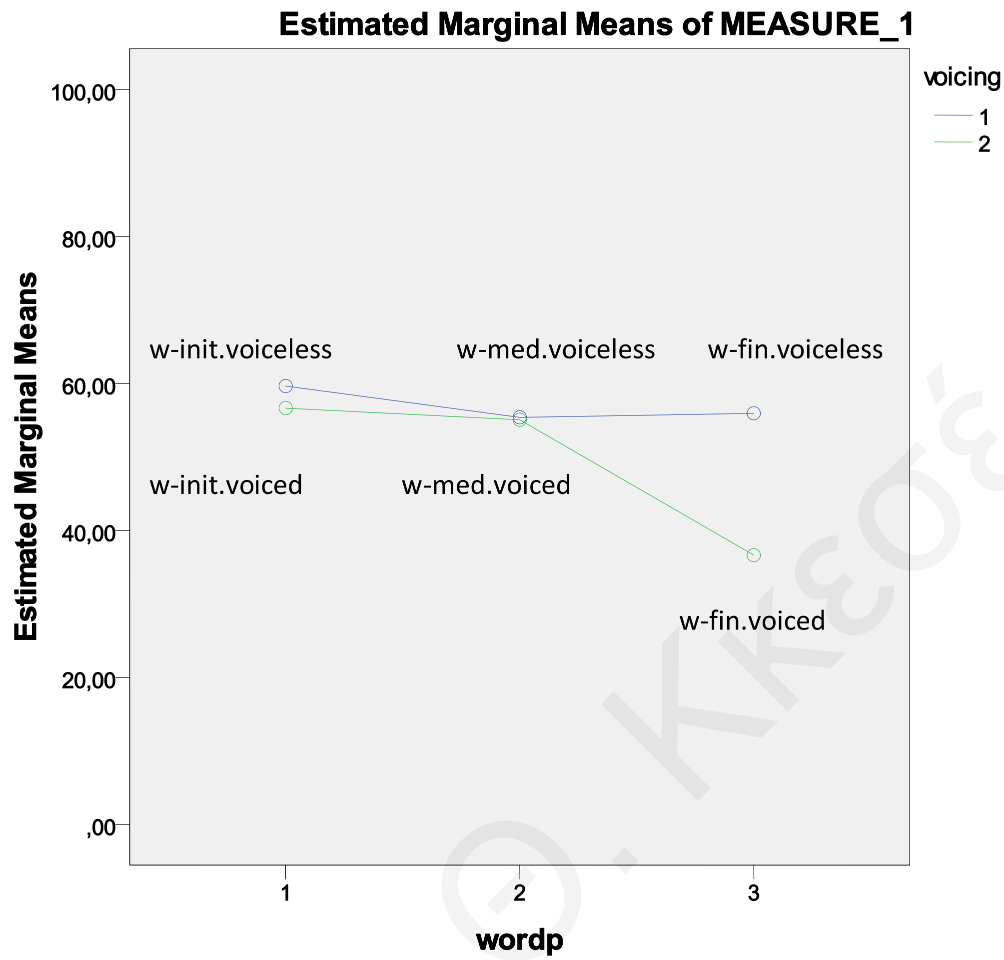

Figure 16: Interaction between voicing X word position (better performance in voiceless plosives in word-initial position)

The third MANOVA (voicing X place of articulation X syllable) indicated significant main effects for all variables: voicing $F(1,112) = 20.76$, $p < .001$, $\eta^2 = .16$, place of articulation $F(2,224) = 3.66$, $p < .05$, $\eta^2 = .03$, and syllable $F(1,112) = 30.12$, $p < .001$, $\eta^2 = .21$. Specifically, for voicing participants performed better in voiceless (*M* = 54.44, *SE* = 1.90) than voiced plosive consonants (*M* = 46.28, *SE* = 1.77). With reference to the place of articulation, pairwise comparisons indicated that performance was significantly better for velar (*M* = 52.59, *SE* = 2.02) rather than bilabial (*M* = 51.00, *SE* = 1.95) or alveolar plosive consonants (*M* = 47.48, *SE* = 1.89). As to the syllable, performance was significantly better for onset (*M* = 56.57, *SE* = 2.46) compared to coda (*M* = 44.15, *SE* = 1.29), especially for bilabial consonants (for [p] % correct *M* = 60.23, *SD* = 33.54; for [b] *M* = 53.83, *SD* = 32.87) compared to alveolar (for [t] % correct *M* = 53.51, *SD* = 32.11; for [d] *M* = 57.20, *SD* = 30.90) and velar consonants (for [k] % correct M = 59.42, SD = 31.59; for [g] M = 55.21, SD = 31.82). Significant interactions were identified between syllable X voicing $F(1,112) = 17.33$ $p < .001$, $\eta^2 = .13$ as well as place of articulation X voicing $F(2,224) = 9.72$ $p < .001$, $\eta^2 = .08$. Concerning the first interaction (syllable X voicing), this indicated that participants did better in voiceless consonants especially at onset position (voiceless M = 57.72, SE = 2.65; voiced M = 55.42, SE = 2.56) compared to coda (voiceless M = 51.16, SE = 1.72; voiced M = 37.14, SE = 2.02). However, effect of voicing (advantage for voiceless over voiced) was most pronounced for coda (Figure 17). The second interaction (place of articulation X voicing) indicated that performance was better for voiceless velar (voiceless M = 58.77, SE = 2.38; voiced M = 46.41, SE = 2.39) and bilabial consonants (voiceless M = 57.55, SE = 2.65; voiced M = 44.47, SE = 2.20) compared to alveolar (voiceless M = 47.00, SE = 2.19; voiced M = 47.96, SE = 2.49).

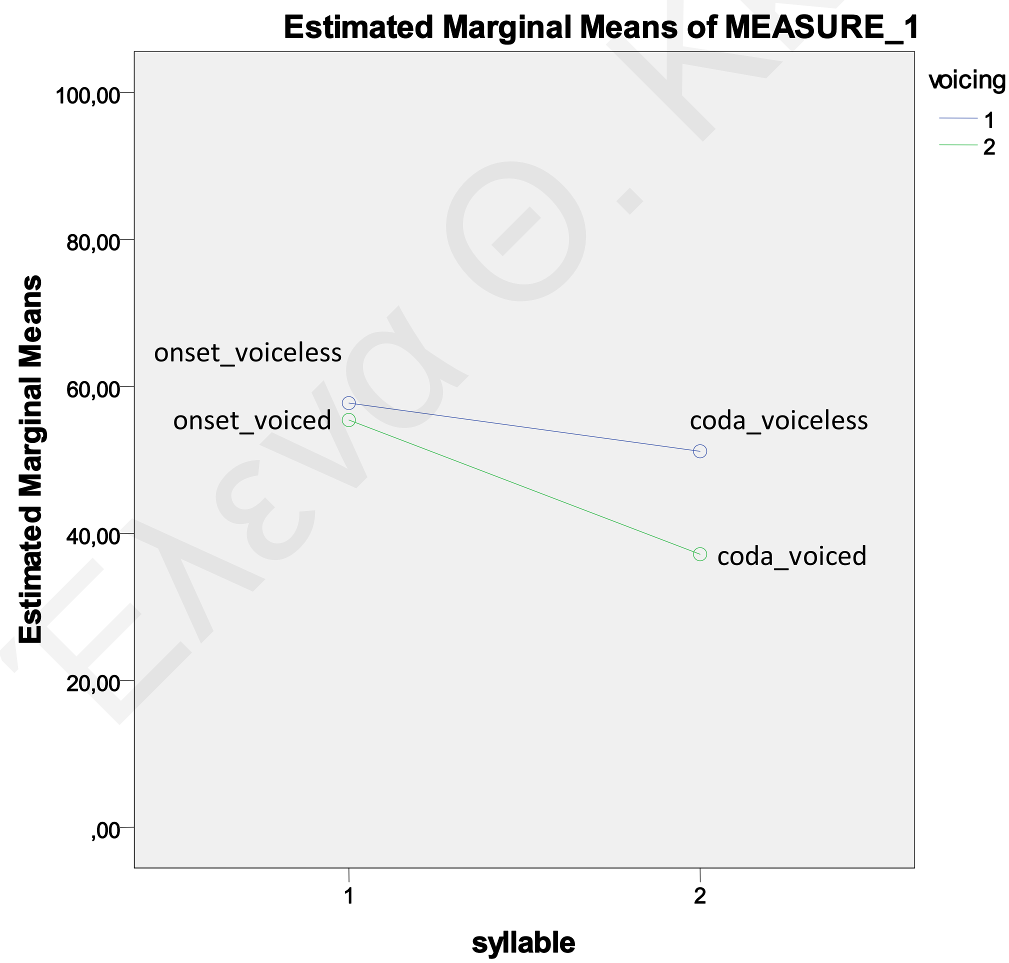

Figure 17: Interaction between voicing X syllable position (better performance in voiceless onset plosives)

Summary for the Word Identification task

Generally, the first task indicated a better overall performance in voiceless, velar, word-initial, onset plosives. All three MANOVAs conducted pointed to a significant main effect of voicing on performance with participants doing much better in voiceless plosives than their voiced counterparts. For the second MANOVA, better performance was found for plosive consonants in word-initial position, followed by plosives in word-medial position while the worst performance was found in plosives in word-final position. For the third MANOVA, participants did significantly better in plosives in onset position rather than in coda position. Moreover, significant interactions were revealed for all the three MANOVAs performed pointing to the importance of the voicing contrast factor and how this factor may interact with the other factors.

2.1.1. Rank Order of the factors affecting plosive consonants identification

This first part of the study examined which phonological environments make it more difficult for CG users of L2 English to identify plosive consonants using data from Task 1. Further, it provides an indication of the rank order for these phonological environments in order to see what factor is identified as most important, thus having the greatest influence on plosive consonant identification. For this purpose, descriptive statistics combining information about all investigated factors regarding Task 1[16] involving voicing, place of articulation, word position, and syllable position was used to determine the frequency of the factors identified in both the literature study as well as in the empirical study.

From a descriptive look, by ranking the means for all combinations in descending order (Table 9), it seems that phonemes in the first (best performance) rows of this table tend to be the ones in onset syllable position. Specifically, the actual difference between scores tends to be greater as a function of syllable position rather than a function of the other factors. Voicing seems to have the second greatest influence on plosive consonant identification since voiceless have higher scores while the ones with the lowest tend to be voiced. Word position follows and is identified as the third most important factor while the last factor identified involves the place of articulation factor. The different means used for analysing the data, thus, indicate to significance above chance for responses even thought Task 1 involved a forced choice task.

[16] The data for Task 2 was not sufficient to allow a similar ranking of the investigated factors.

	Rank Order	***M(SD)***	**N**
PPVPAWS			
Variable 1: word-medial onset [p]	1	62.39(40.52)	113
Variable 2: word-initial onset [k]	2	60.47(38.84)	113
Variable 3: word-initial onset [g]	3	60.32(40.78)	113
Variable 4: word-initial onset [p]	4	59.82(42.47)	113
Variable 5: word-initial onset [t]	5	58.63(37.91)	113
Variable 6: word-final coda [k]	6	58.41(34.08)	113
Variable 7: word-medial onset [d]	7	56.93(35.13)	113
Variable 8: word-initial onset [d]	8	56.86(40.12)	113
Variable 9: word-medial onset [b]	9	56.19(39.46)	113
Variable 10: word-final coda [p]	10	54.72(35.18)	113
Variable 11: word-final coda [t]	11	54.65(37.58)	113
Variable 12: word-initial onset [b]	12	52.74(41.06)	113
Variable 13: word-medial onset [k]	12	52.74(42.18)	113
Variable 14: word-medial onset [g]	13	52.04(40.23)	113
Variable 15: word-medial onset [t]	14	51.03(35.79)	113
Variable 16: word-final coda [d]	15	38.50(38.53)	113
Variable 17: word-final coda [g]	16	36.58(34.42)	113
Variable 18: word-final coda [b]	17	34.81(33.45)	113

PPVPAWS = Participants' Performance in terms of Voicing, Place of Articulation, Word position, and Syllable position

% correct

Table 9: Descriptive Statistics for performance of participants in terms of the four investigated factors in descending order (better performance in plosives in onset position).

These indications based on descriptive statistics are further supported with the Multivariate Analyses of Variance (MANOVAs) that have preceded. Specifically, the third MANOVA indicated a significant effect for syllable position, $F(1,112) = 30.12$, $p < .001$, $\eta^2 = .21$. This leads to the conclusion that the syllable position factor consistently appears significant in both the MANOVAs and the descriptives. Further, all three MANOVAs performed for Task 1 indicated a significant main effect of voicing on performance with overall performance (% correct answers) being higher for voiceless plosive consonants compared to voiced. Main effect for voicing was identified for the first MANOVA (place of articulation X voicing), $F(1,112) = 16.50$, $p < .001$, $\eta^2 = .13$, second MANOVA (voicing X place of articulation X word position), $F(1,112) = 21.60$, $p < .001$, $\eta^2 = .16$, and third MANOVA (voicing X place of articulation X syllable), $F(1,112) = 20.76$, $p < .001$, $\eta^2 = .16$. Word position had the next higher value, $F(1.8,202.46) = 13.54$, $p < .001$, $\eta^2 = .11$ (Greenhouse-Geisser corrected). Finally, a main effect for place of articulation was only identified for the third MANOVA (voicing X place of articulation X syllable), $F(2,224) = 3.66$, $p < .05$, $\eta^2 = .03$.

Table 10 is a summary of the factors influencing the identification of plosive consonants in order of importance as these were revealed through the descriptive statistics and the MANOVAs conducted.

Rank Order	FACTOR
1	Syllable position
2	Voicing contrast
3	Word position
4	Place of articulation

Table 10: Summary of important factors as revealed through participants' performance (task 1).

2.2. Words-in-Sentences Identification Task

During the Spring semester of 2011, the students who participated in the study had to undertake a second task besides the Word Identification task (Task 1). However, the Words-in-sentences Identification task (Task 2) had only one version since it involved a more demanding task and was administered to the 30 students (*N* 30) of the specific semester.

The statistical procedure that was followed for the first task was followed for the second task as well. This involved a Multivariate Analysis of Variance (MANOVA) with three articulation levels (bilabial, alveolar, velar) and two voicing levels (voiceless, voiced) as within subject factors. Two additional MANOVAs were run focusing on word position (initial, medial, final), and syllable position (onset, coda) as a third within subjects factor. A MANOVA could not be performed for the fourth factor, namely utterance position, due to insufficient data. Assumption of sphericity was checked using the Mauchly's test while in case of sphericity violation, degrees of freedom were adjusted using Greenhouse-Geisser corrections. Repeated contrasts were performed to break down main and interaction effects comparing the three articulation levels and the three word position levels.

The first MANOVA indicated a significant main effect of voicing $F(1,29) = 20.12$, $p < .001$, $\eta^2 = .41$ and place of articulation $F(2,58) = 14.32$, $p < .001$, $\eta^2 = .33$ but no interaction between the two factors. Concerning voicing, participants performed considerably better in perceiving voiceless plosive consonants (for voiceless consonants % correct $M = 47.33$, $SE = 3.15$) than their voiced counterparts (for voiced consonants % correct $M = 36.37$, $SE = 3.53$). With reference to place of articulation, overall performance (% correct answers) was higher for bilabial (for [p] % correct $M = 51.67$, $SD = 20.69$; for [b] $M = 37.33$, $SD = 21.64$) and velar (for [k] % correct $M = 51.00$, $SD = 21.23$; for [g] $M = 43.67$, $SD = 24.70$) but not for alveolar consonants (for [t] % correct $M = 39.33$, $SD = 21.16$; for [d] $M = 29.00$, $SD = 17.49$). Specifically, there was an advantage of velar consonants ($M = 47.33$, $SE = 3.67$) compared to bilabial ($M = 44.50$, $SE = 3.67$) but not to the alveolar and also an advantage of the bilabial consonants compared to alveolar ($M = 34.17$, $SE = 3.14$). Examinations of pairwise comparisons indicated a statistically significant difference between velar and the other two categories (bilabial, alveolar) $p < .001$ but not a significant difference between bilabial and velar plosive consonants (Figure 18). No other significant main effects were identified.

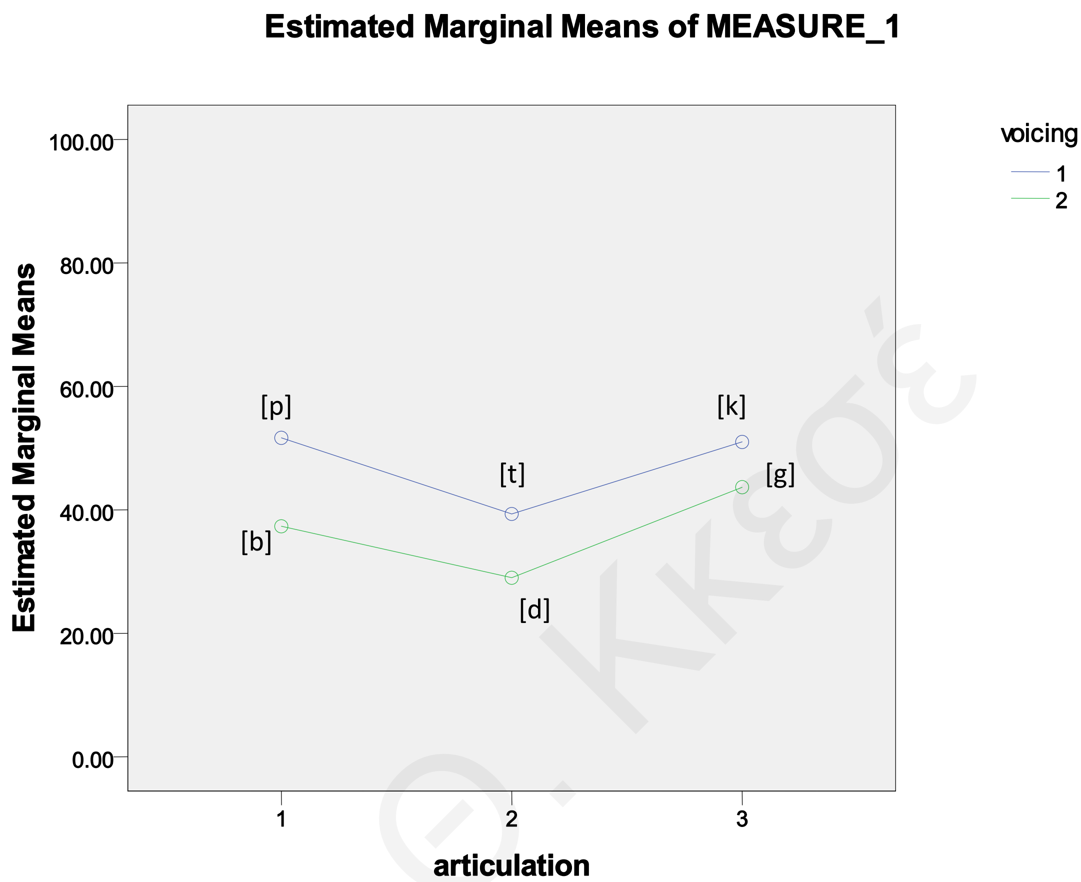

Figure 18: Interaction between voicing X place of articulation (better performance in velar and bilabial plosives)

Two separate MANOVAs were performed for the second factor, which is word position (voicing X place of articulation X word position). The first 2X3X2 MANOVA focused on comparing the word-medial and word-final categories indicating a better overall performance in the word-final position (Table 11). The word-initial category was not included because of insufficient data.

	word-medial	word-final	N
	M(SD)	*M(SD)*	
PPVPA			
Variable1: voiceless bilabial	27.78(23.30)	80.00(40.68)	30
Variable2: voiceless alveolar	34.67(23.45)	44.00(24.86)	30
Variable3: voiceless velar	36.67(26.04)	66.67(33.04)	30
Variable4: voiced bilabial	12.22(18.53)	33.33(47.95)	30
Variable5: voiced alveolar	24.00(19.93)	34.00(22.98)	30
Variable6: voiced velar	44.17(29.86)	16.67(30.32)	30

PPVPA = Participants' Performance in terms of Voicing, Place of Articulation, and Word position

% correct

Table 11: Descriptive statistics for performance of participants in terms of word position, voicing, and place of articulation (better performance in plosives in word-final position).

Significant main effects were identified for all variables: word position $F(1,29) = 25.37$, $p < .001$, $\eta^2 = .47$ and voicing $F(1,29) = 46.18$, $p < .001$, $\eta^2 = .61$. The first main effect (word position) indicated that participants performed better in word-final position ($M = 45.78$, $SE = 3.81$) compared to word-medial ($M = 29.92$, $SE = 3.12$ $p < .001$). The advantage of voiceless ($M = 48.30$, $SE = 3.23$) over voiced plosives ($M = 27.40$, $SE = 3.68$) identified in previous analyses was also maintained. The effect of articulation was marginal, $F(2,58) = 3.11$, p > .05 ($p = .05$), $\eta^2 = .10$. Contrasts revealed that performance was significantly better for velar consonants ($M = 41.04$, $SE = 3.78$) compared to alveolar ($M = 34.17$, $SE = 3.14$), $F(1,29) = 8.85$ but the difference between bilabial and alveolar, and between bilabial and velar was not significant.

Interactions were also identified between word position X place of articulation $F(1.62,47.08) = 21.39$ $p < .001$, $\eta^2 = .43$ (Greenhouse-Geisser corrected), word position X voicing $F(1,29) = 37.86$, $p < .001$, $\eta^2 = .57$, place of articulation X voicing $F(2,58) = 4.72$, $p < .01$, $\eta^2 = .14$, as well as word position X place of articulation X voicing $F(2,58) = 8.31$, $p < .001$, $\eta^2 = .22$. With reference to the first interaction (word position X place of articulation), to break down the interaction, contrasts were performed comparing all places of articulation.

These revealed significant interactions when comparing medial and final word position for bilabial plosives compared to alveolar, $F(1,29) = 31.99$, $p < .001$ and to velar plosives, $F(1,29) = 26.51$, $p < .001$. Looking at the interaction graph (Figure 19), these effects reflect that final word position (compared to medial) improved performance significantly more for bilabial plosives than it did for alveolar or velar plosives. There was no significant interaction term when comparing the effect of word position for alveolar compared to velar plosives.

The advantage for voiceless over voiced plosives was present in both positions (word-medial: voiceless, $M = 33.04$, $SE = 3.50$, voiced $M = 26.80$, $SE = 3.58$; word-final: voiceless, $M = 63.56$, $SE = 4.02$, voiced, $M = 28.00$, $SE = 4.73$). The word position X voicing interaction was such that the advantage for word-final compared to word-medial position was only present for voiceless plosives (Figure 20). The third interaction (voicing X place of articulation) indicated that the advantage for voiceless over voiced plosives was significantly greater for bilabial compared to alveolar plosives, $F(1,29) = 8.25$, $p < .01$ (bilabial: voiceless $M = 53.89$, $SE = 4.71$, voiced, $M = 22.78$, $SE = 4.76$; alveolar: voiceless, $M = 39.33$, $SE = 3.74$, voiced: $M = 29.00$, $SE = 3.23$) (see Figure 21). Finally, for the fourth three-way interaction (word position X place of articulation X voicing) contrasts indicated the following significant effects:

1) The contrast comparing the medial versus the final position for alveolar vs. velar and voiced vs. voiceless was significant, $F(1,29) = 24.82$, $p < .001$. For the medial word position, the effect of voicing was reversed, such that there was an advantage for voiceless over voiced for alveolar (voiceless $M = 34.67$, $SE = 4.28$; voiced $M = 24.00$, $SE = 3.64$) but an advantage for voiced over voiceless for velar (voiceless $M = 36.67$, $SE = 4.76$; voiced $M = 44.17$, $SE = 5.45$) whereas for final word position, the advantage of voiceless over voiced was present for both alveolar and velar plosives (alveolar: voiceless $M = 44.00$, $SE = 4.54$; voiced $M = 34.00$, $SE = 4.20$; velar: voiceless $M = 66.67$, $SE = 6.03$; voiced $M = 16.67$, $SE = 5.54$).
2) The contrast comparing the medial versus the final word position for alveolar vs. bilabial and voiced vs. voiceless was also significant, $F(1,29) = 5.02$, $p < .05$. For medial word position, there was an advantage of voicing for both bilabial (voiceless $M = 27.78$, $SE = 4.25$; voiced $M = 12.22$, $SE = 3.38$) and alveolar plosives (voiceless $M = 34.67$, $SE = 4.28$; voiced $M = 24.00$, $SE = 3.64$) but for the final word position, the advantage for voiceless over voiced appeared to be greater for bilabial (voiceless $M =$

80.00, *SE* = 7.43; voiced *M* = 33.33, *SE* = 8.75) compared to alveolar (voiceless *M* = 44.00, *SE* = 4.54; voiced *M* =34.00; *SE* = 4.20).

These contrasts are shown on Figures 22-25. Generally, the effect of word position seemed to be the same for both the word-medial and -final categories in terms of alveolar plosives. Nonetheless, for bilabial plosives, there seemed to be a greater effect of word position for voiceless than voiced consonants. Lastly, for velar plosives there appeared to be an advantage for voiceless in the word-final category.

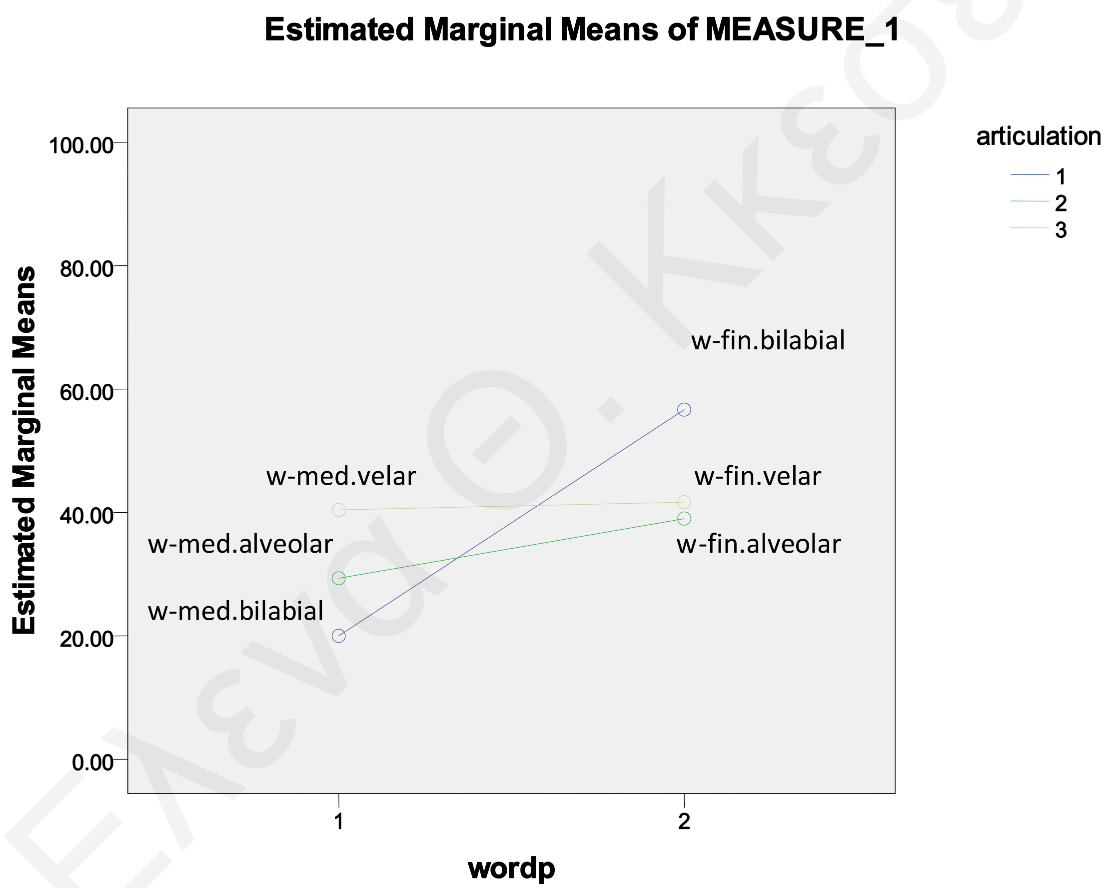

Figure 19: Interaction between word position X place of articulation (better performance in word-final bilabial plosives)

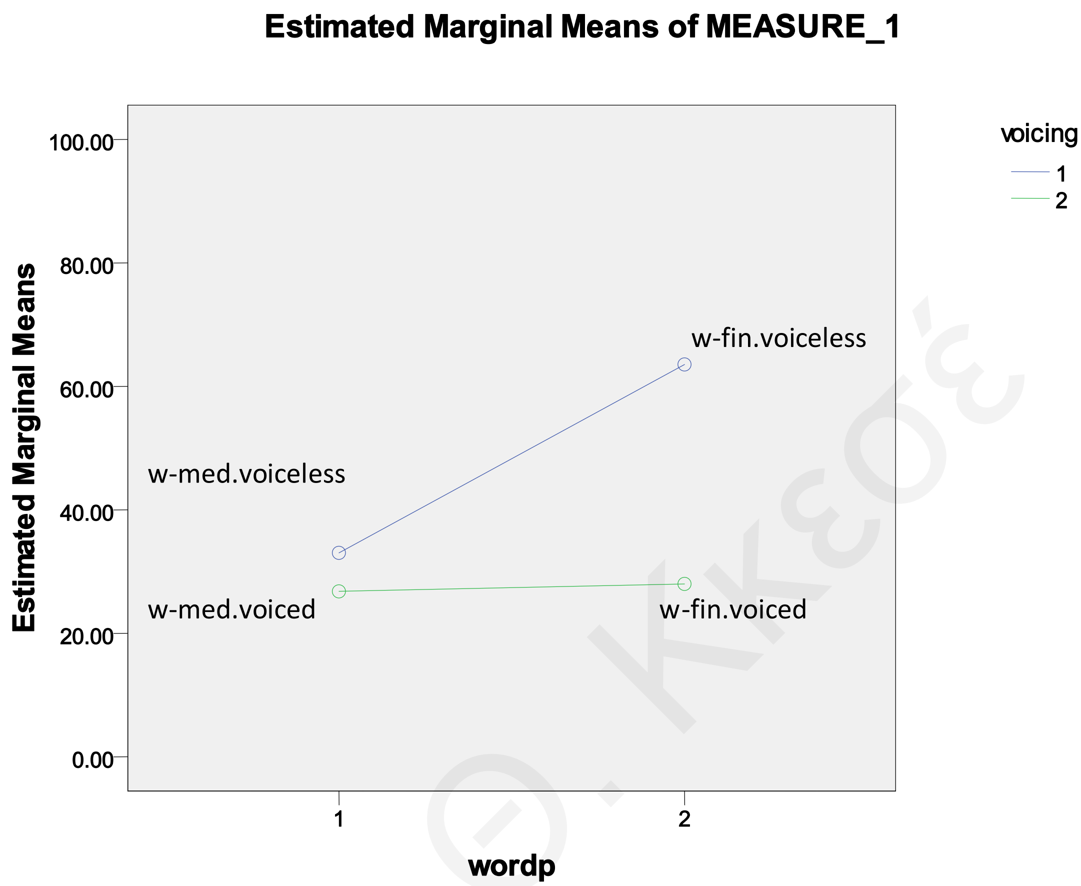

Figure 20: Interaction between word position X voicing (better performance in voiceless word-final plosives)

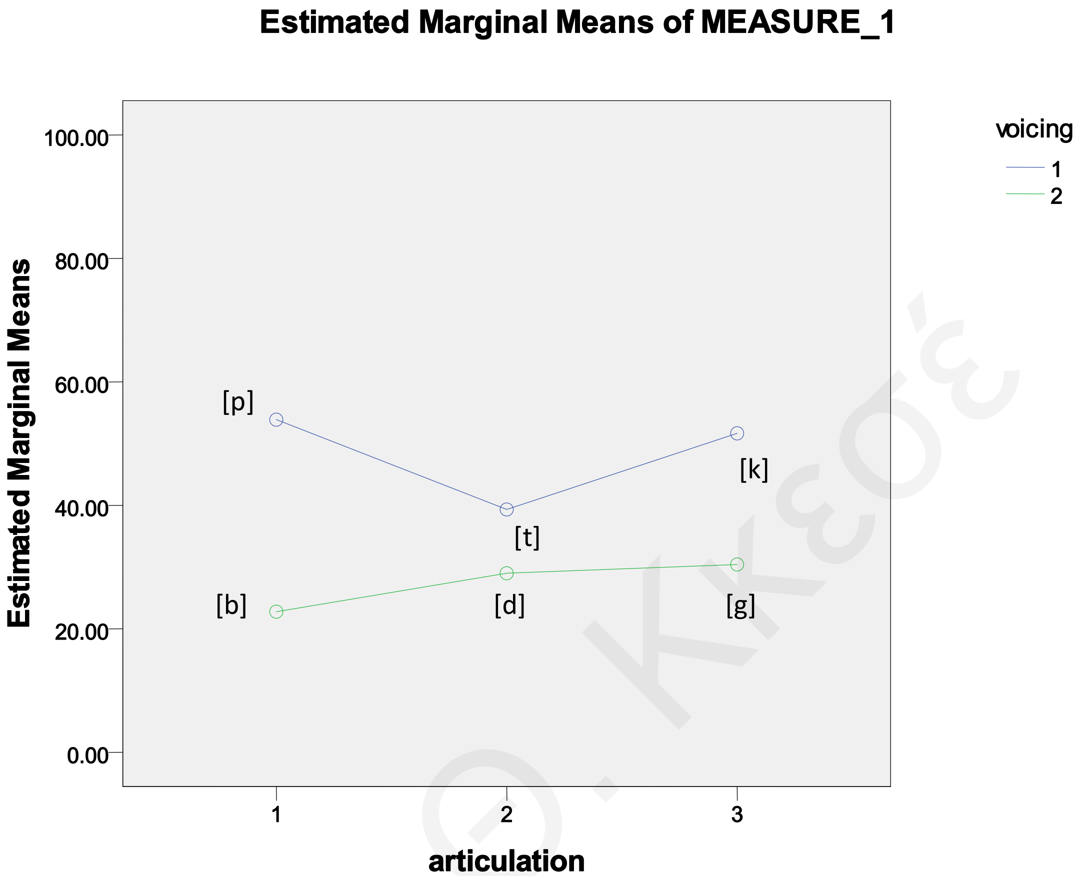

Figure 21: Interaction between place of articulation X voicing (better performance in voiceless bilabial plosives)

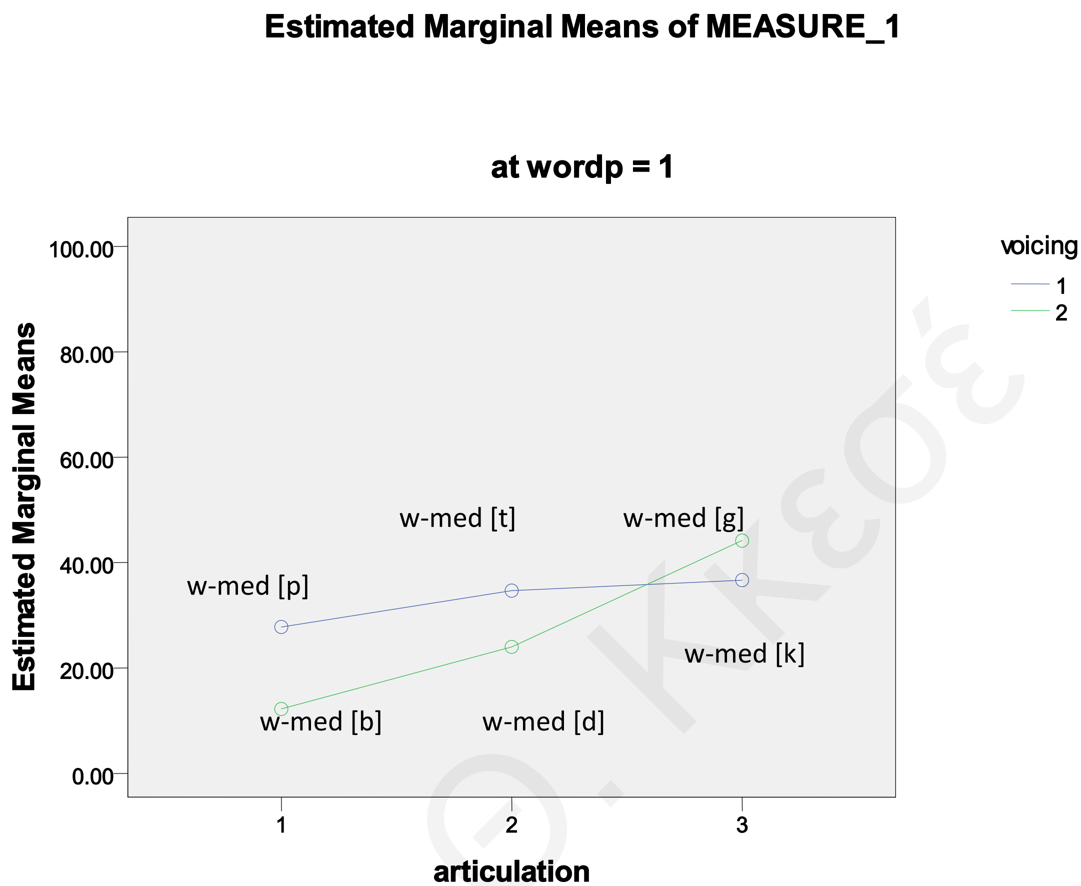

Figure 22: Interaction between word position X place of articulation X voicing (better performance in voiced word-medial velar plosive)

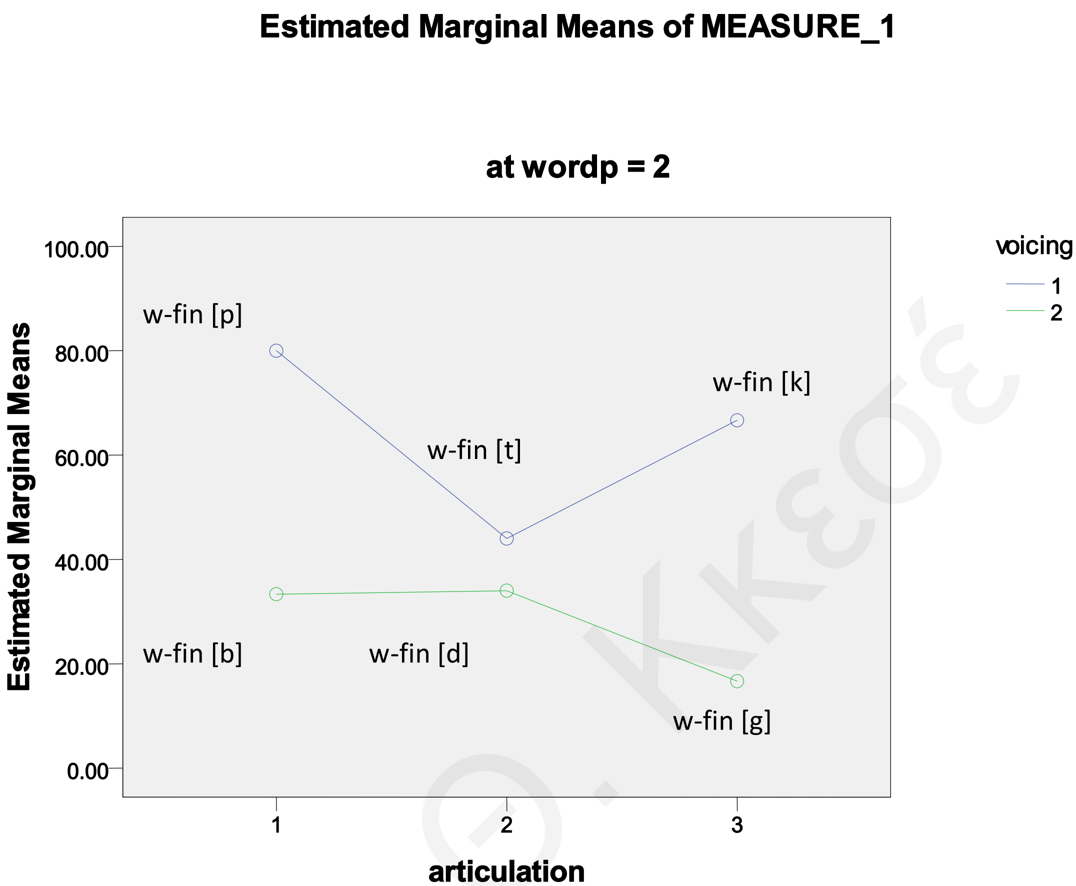

Figure 23: Interaction between word position X place of articulation X voicing (better performance in voiceless plosives in word-final position)

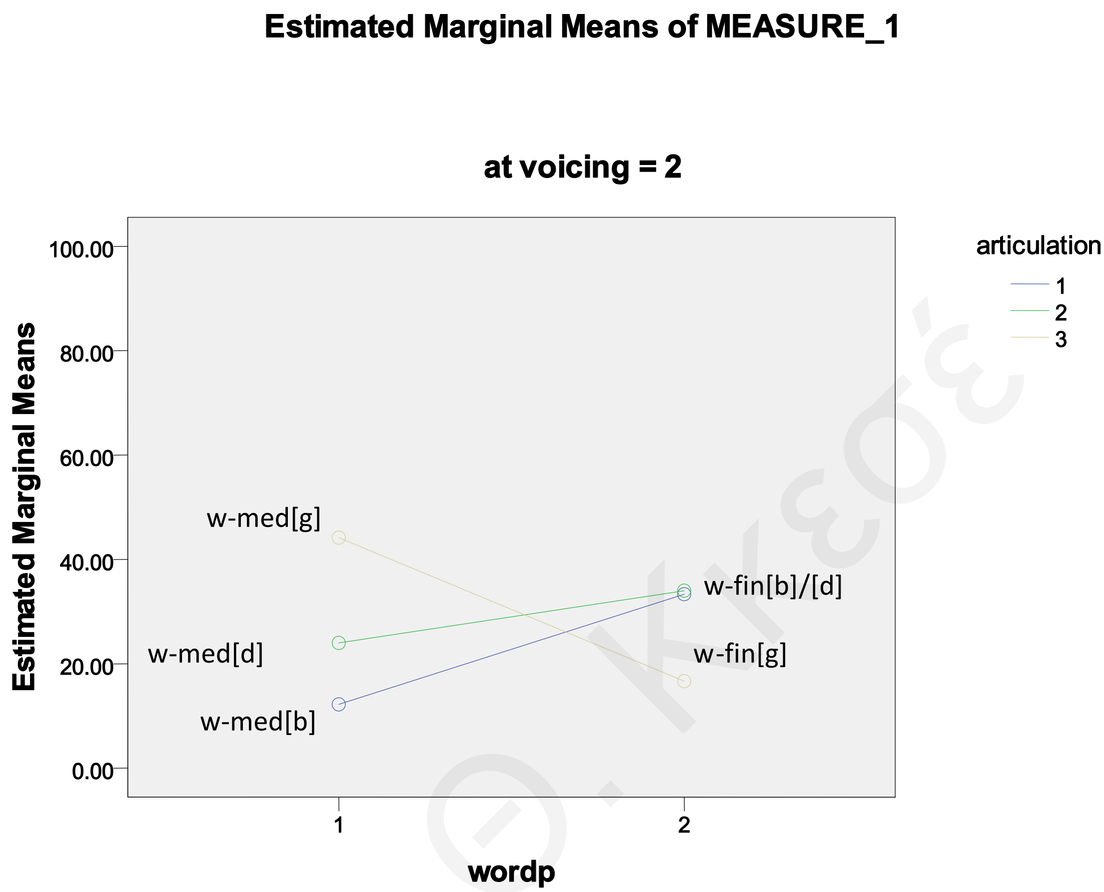

Figure 24: Interaction between word position X place of articulation X voicing (better performance in voiced velar plosive in word-medial position)

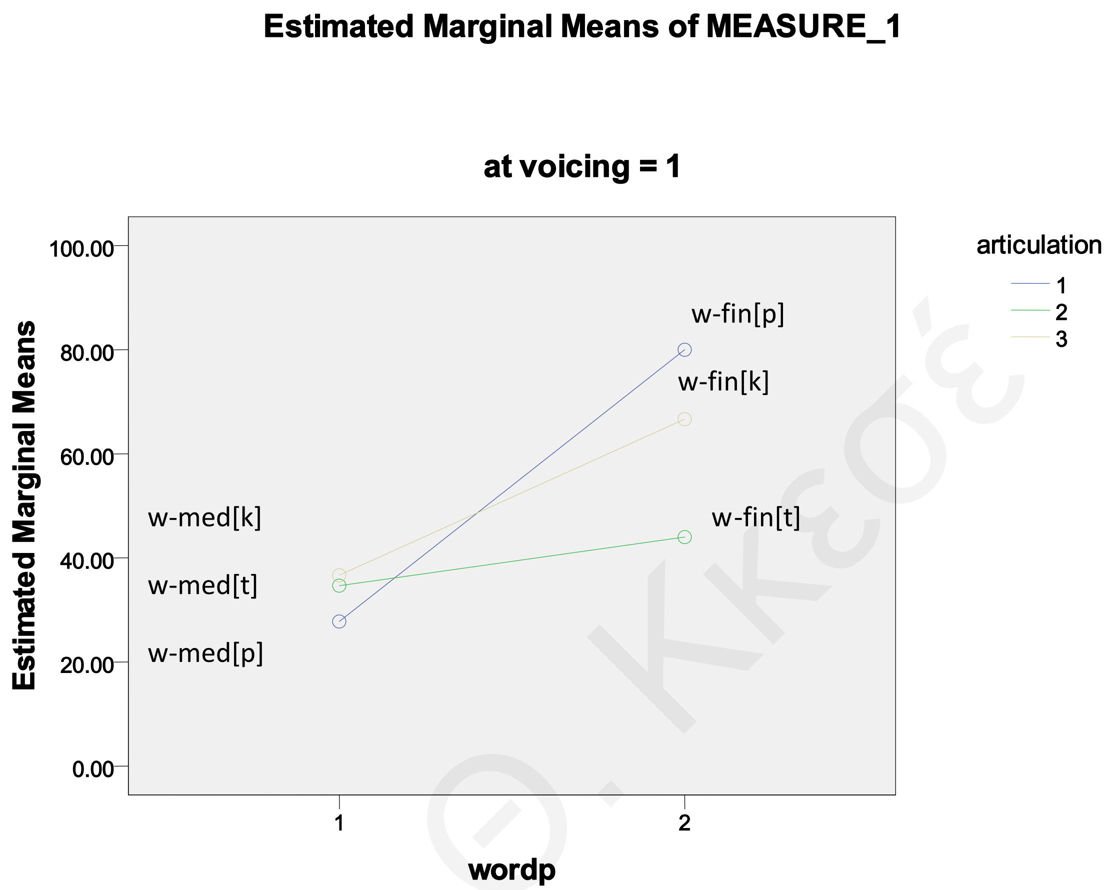

Figure 25: Interaction between word position X place of articulation X voicing (better performance in voiceless plosives in word-final position)

The second MANOVA (2X2X3) compared voicing X place of articulation X word position. For place of articulation, alveolar plosives were not included, due to insufficient data. Results overall indicated better overall performance for velar plosives compared to bilabials (Table 12).

	word-initial	word-medial	word-final	N
	M(SD)	*M(SD)*	*M(SD)*	
PPVPA				
Variable1: voiceless bilabial	59.44(24.24)	27.78(23.30)	80.00(40.68)	30
Variable2: voiceless velar	58.33(28.87)	36.67(26.04)	66.67(33.04)	30
Variable3: voiced bilabial	50.00(29.68)	12.22(18.53)	33.33(47.95)	30
Variable4: voiced velar	56.67(30.04)	44.17(29.86)	16.67(30.32)	30

PPVPA = Participants' Performance in terms of Voicing, Place of Articulation, and word position

% correct

Table 12: Descriptive results for performance of participants in terms of word position, voicing, and place of articulation (better performance in velar plosives than bilabial ones).

A main effect was identified for word position $F(2,58) = 30.00$, $p < .001$, $\eta^2 = .51$ and voicing $F(1,29) = 32.71$, $p < .001$, $\eta^2 = .53$, as well as an interaction between word position X place of articulation $F(1.44,41.81) = 13.25$, $p < .001$, $\eta^2 = .31$ (Greenhouse-Geisser corrected), and an interaction between word position X voicing $F(2,58) = 31.20$, $p < .001$, $\eta^2 = .52$. Concerning the main effect (word position), contrasts indicated an advantage of the word-initial category ($M = 56.11$, $SE = 4.09$) compared to the word-medial ($M = 30.21$, $SE = 3.23$), $F(1,29) = 26.90$, $p < .011$ but not to the word-final category and also an advantage of the word-final category ($M = 49.17$, $SE = 4.24$) compared to the word-medial, $F(1,29) = 26.90$, $p < .001$. The second main effect (voicing) indicated a better overall performance for voiceless consonants ($M = 54.82$, $SE = 3.44$) compared to voiced ($M = 35.51$, $SE = 4.00$). With reference to the first interaction (word position X place of articulation), contrasts revealed significant interactions of articulation (bilabial vs. velar) for all word positions:

1) Performance was better for velar compared to bilabial for the medial (bilabial $M = 20.00$, $SE = 3.03$; velar $M = 40.42$, $SE = 4.00$) but not for the initial word position category (bilabial $M = 54.72$, $SE = 4.44$; velar $M = 57.50$, $SE = 4.74$), $F(1,29) = 14.26$, $p < .01$;

2) For the final word position compared to the medial one, the advantage for velar over bilabial articulation was reversed (bilabial *M* = 56.67, *SE* = 5.74; velar *M* = 41.67, *SE* = 4.54), $F(1,29) = 26.51$, $p < .001$;
3) The contrast for articulation between final vs. initial word position was also significant, $F(1,29) = 4.34$, $p < .05$, as an advantage for bilabial over velar over bilabial appeared for final but not for initial word position (Figure 26).

For the second interaction (word position X voicing), contrasts indicated that the advantage for voiceless over voiced was significantly greater for the word-final category (voiceless *M* = 73.33, *SE* = 4.79; voiced *M* = 25.00, *SE* = 5.87) compared to the word-initial (voiceless *M* = 58.89, *SE* = 4.12; voiced *M* = 53.33, *SE* = 4.77), $F(1,29) = 37.37$, $p < .001$, and for the word-final category compared to the word-medial category (voiceless *M* = 32.22, *SE* = 3.83; voiced *M* = 28.19, *SE* = 3.98), $F(1,29) = 40.67$, $p < .001$ (Figure 27).

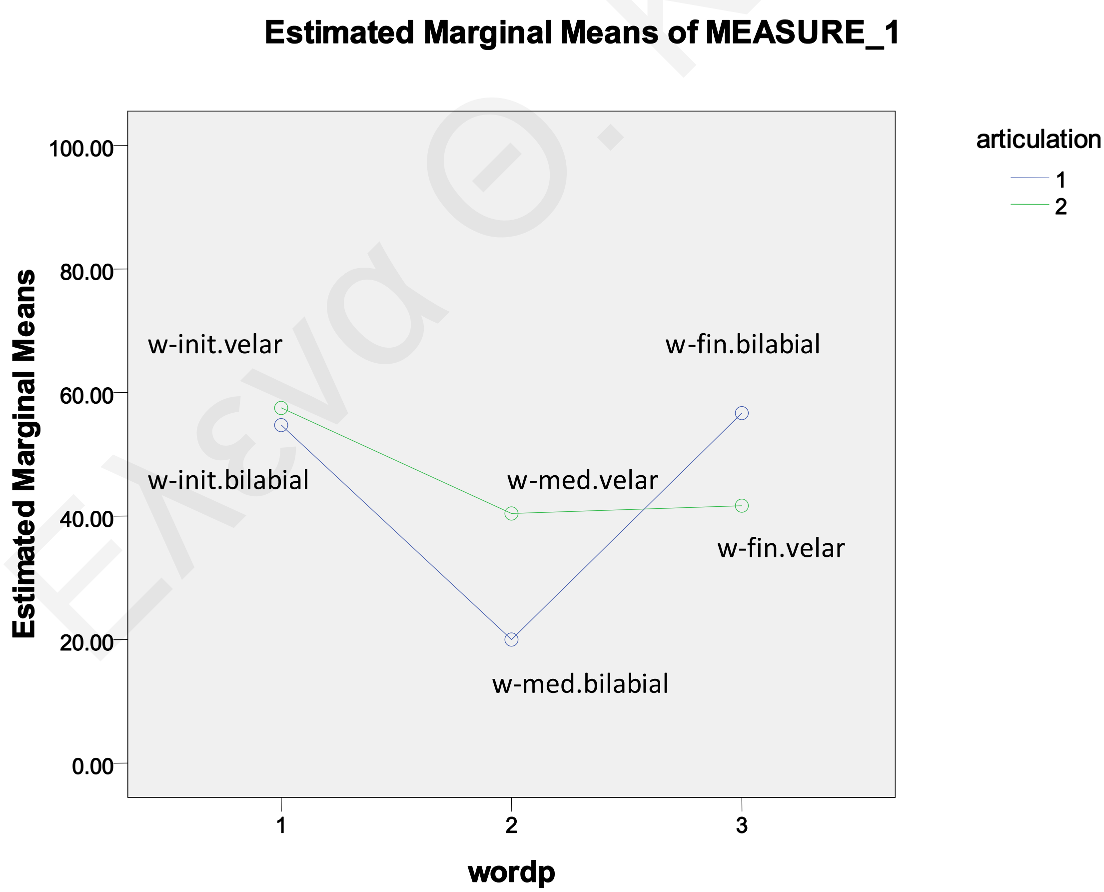

Figure 26: Interaction between word position X place of articulation (better performance in word-intial velar and -final bilabial plosives)

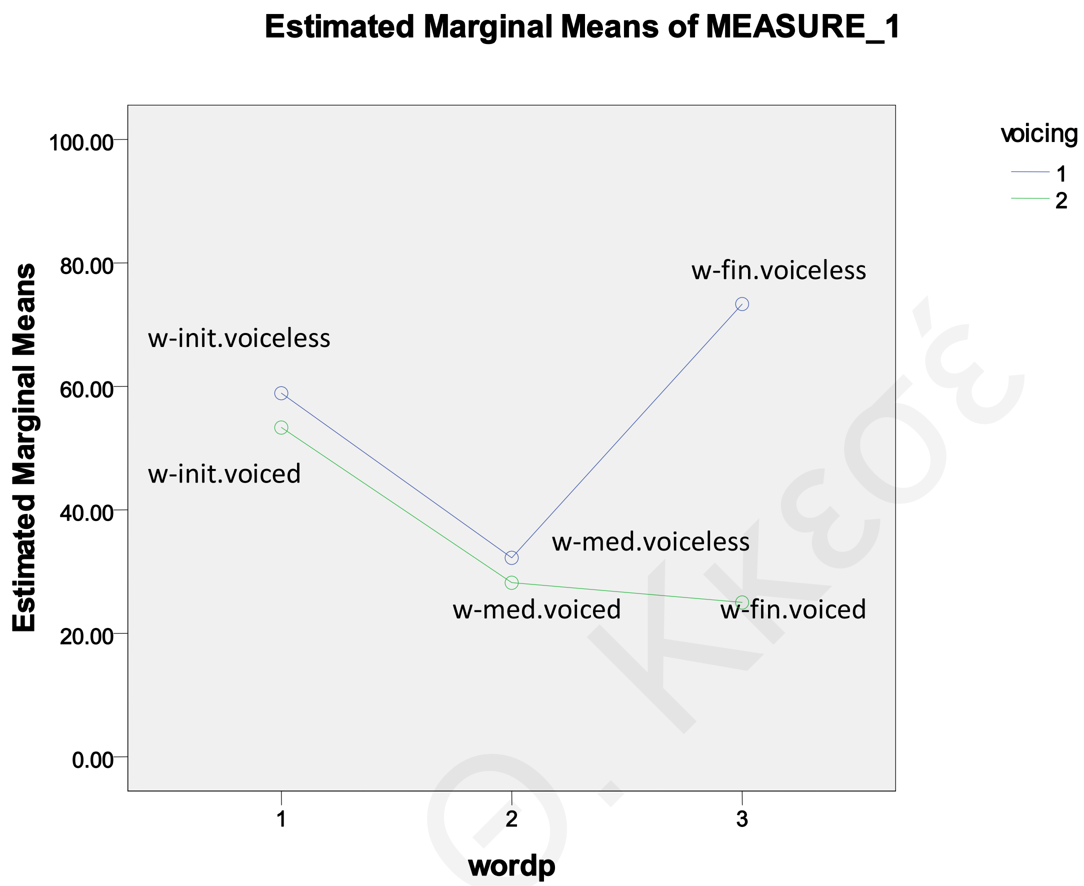

Figure 27: Interaction between word position X voicing (better performance in word-final voiceless plosives)

The third MANOVA focused on syllable position as a function of place of articulation and voicing (2X3X2). Overall, the participants seemed to perform better in plosive consonants in coda position (*M* = 45.78, *SE* = 3.81) compared to plosives in onset position (*M* = 40.55, *SE* = 3.24) especially when it comes to [p] and [k] (Table 13).

	onset	**coda**	**N**
	M(SD)	*M(SD)*	
PPVPA			
Variable1: voiceless bilabial	48.52(21.14)	80.00(40.68)	30
Variable2: voiceless alveolar	35.33(25.01)	44.00(24.86)	30
Variable3: voiceless velar	47.50(23.99)	66.67(33.04)	30
Variable4: voiced bilabial	37.78(23.45)	33.33(47.95)	30
Variable5: voiced alveolar	23.33(20.40)	34.00(22.98)	30
Variable6: voiced velar	50.83(25.83)	16.67(30.32)	30

PPVPA = Participants' Performance in terms of Voicing, Place of Articulation, and syllable position

% correct

Table 13: Descriptive statistics for performance of participants in terms of syllable position, place of articulation, and voicing (better performance in plosives in coda position).

Significant main effects were identified for voicing, $F(1,29) = 53.10$, $p < .001$, $\eta^2 = .65$ and place of articulation $F(1.85,53.73) = 17.63$, $p < .001$, $\eta^2 = .38$. With reference to voicing, participants performed considerably better in perceiving voiceless plosive consonants (for voiceless consonants % correct $M = 53.67$, $SE = 3.24$) than their voiced counterparts (for voiced consonants % correct $M = 32.66$, $SE = 3.76$). Regarding place of articulation, there was an advantage of bilabial consonants ($M = 49.91$, $SE = 3.87$) compared to velar ones ($M = 45.42$, $SE = 3.65$) but not to the alveolar ones and also an advantage of the bilabial consonants compared to alveolar ($M = 34.17$, $SE = 3.15$).

Four interactions were identified: between syllable position X place of articulation $F(1.62,46.93) = 6.58$, $p < .01$, $\eta^2 = .19$ (Greenhouse-Geisser corrected), between syllable position X voicing $F(1,29) = 46.88$, $p < .001$, $\eta^2 = .62$, between place of articulation X voicing $F(2,58) = 3.71$, $p < .05$, $\eta^2 = .11$, as well as a three-way-interaction between syllable position X place of articulation X voicing $F(2,58) = 8.79$, $p < .001$, $\eta^2 = .23$. With reference to the first interaction (syllable position X place of articulation), performance was significantly better in coda position for bilabial ($M = 56.67$, $SE = 5.74$) and alveolar ($M = 39.00$, $SE = 3.60$) plosives than in onset position (bilabial $M = 43.15$, $SE = 3.76$; alveolar $M = 29.33$, $SE = 3.55$).

However, the same pattern was not observed for velar plosives since participants seemed to perform better in the onset position (*M* = 49.17, *SE* = 3.97) than in the coda (*M* = 41.67, *SE* = 4.54) (Figure 28). For the second interaction (syllable position X voicing), participants did better in voiceless coda position (*M* = 63.56, *SE* = 4.02) than in voiceless onset position (*M* = 43.78, *SE* = 3.34). Nonetheless, this advantage for coda position was only found for voiceless plosives since participants performed better in voiced onset (*M* = 37.32, *SE* = 3.63) than in voiced coda (*M* = 28.00, *SE* = 4.73) (Figure 29). The third interaction (place of articulation X voicing) simply indicated that overall performance was significantly better for voiceless plosives (bilabial *M* = 64.26, *SE* = 4.70; alveolar *M* = 39.67, *SE* = 3.88; velar *M* = 57.08, *SE* = 4.00) than voiced (bilabial *M* = 35.56, *SE* = 5.13; alveolar *M* = 28.67, *SE* = 3.21; velar *M* = 33.75, *SE* = 4.61). Finally, the fourth interaction (syllable position X place of articulation X and voicing) provided a detailed look into the performance for each phoneme. Specifically, participants did better in voiceless plosives in coda position (bilabial *M* = 80.00, *SE* = 7.43; alveolar *M* = 44.00, *SE* = 4.54; velar *M* = 66.67, *SE* = 6.03) than in onset (bilabial *M* = 48.52, *SE* = 3.86; alveolar *M* = 35.33, *SE* = 4.57; velar *M* = 47.50, *SE* = 4.38) (Figure 30). However, for voiced plosives the performance seemed better at onset position for the bilabial and velar consonants (bilabial *M* = 37.78, *SE* = 4.28; velar *M* = 50.83, *SE* = 4.72) in comparison to coda (bilabial *M* = 33.33, *SE* = 8.75; velar *M* = 16.67, *SE* = 5.54), but this situation was reversed for alveolar plosives (onset *M* = 23.33, *SE* = 3.72; coda *M* = 34.00, *SE* = 4.20) (Figure 31). Consequently, the fourth interaction indicates that the voicing and place of articulation interaction was different for each syllable position.

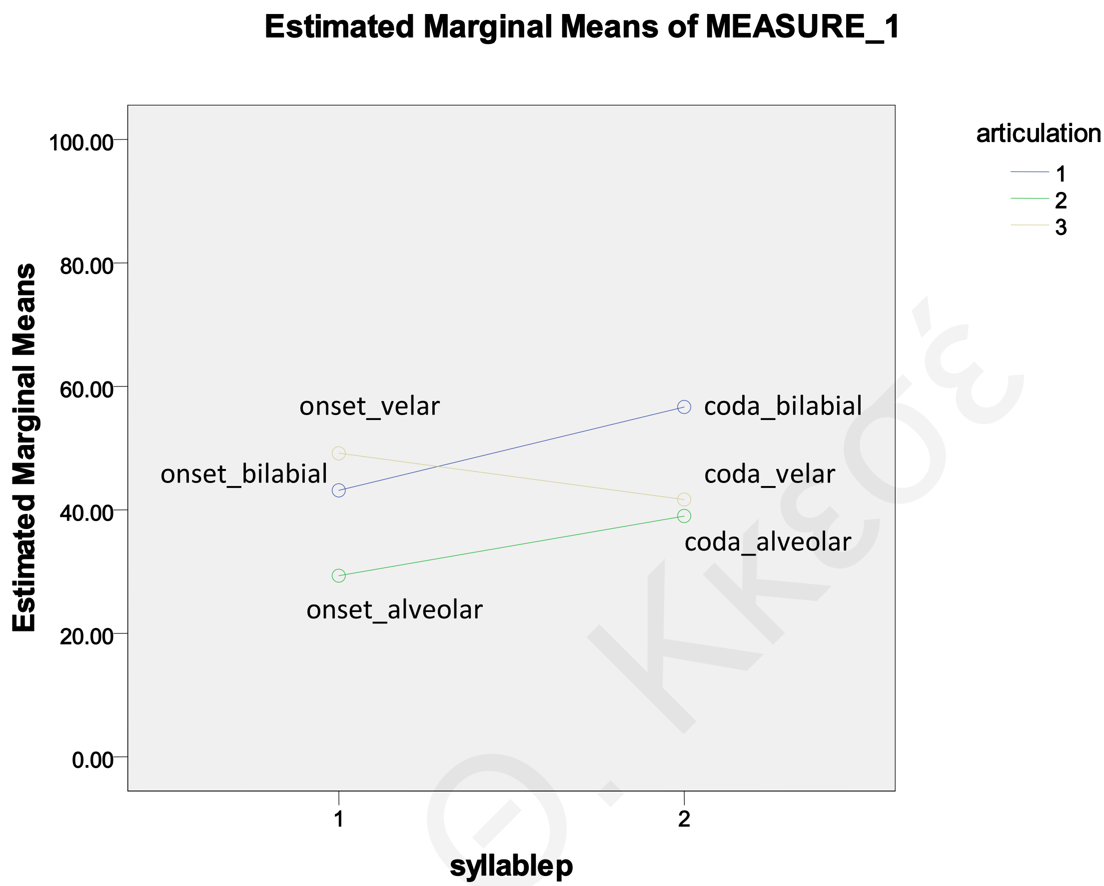

Figure 28: Interaction between syllable position X place of articulation (better performance in onset velar and coda bilabial plosives)

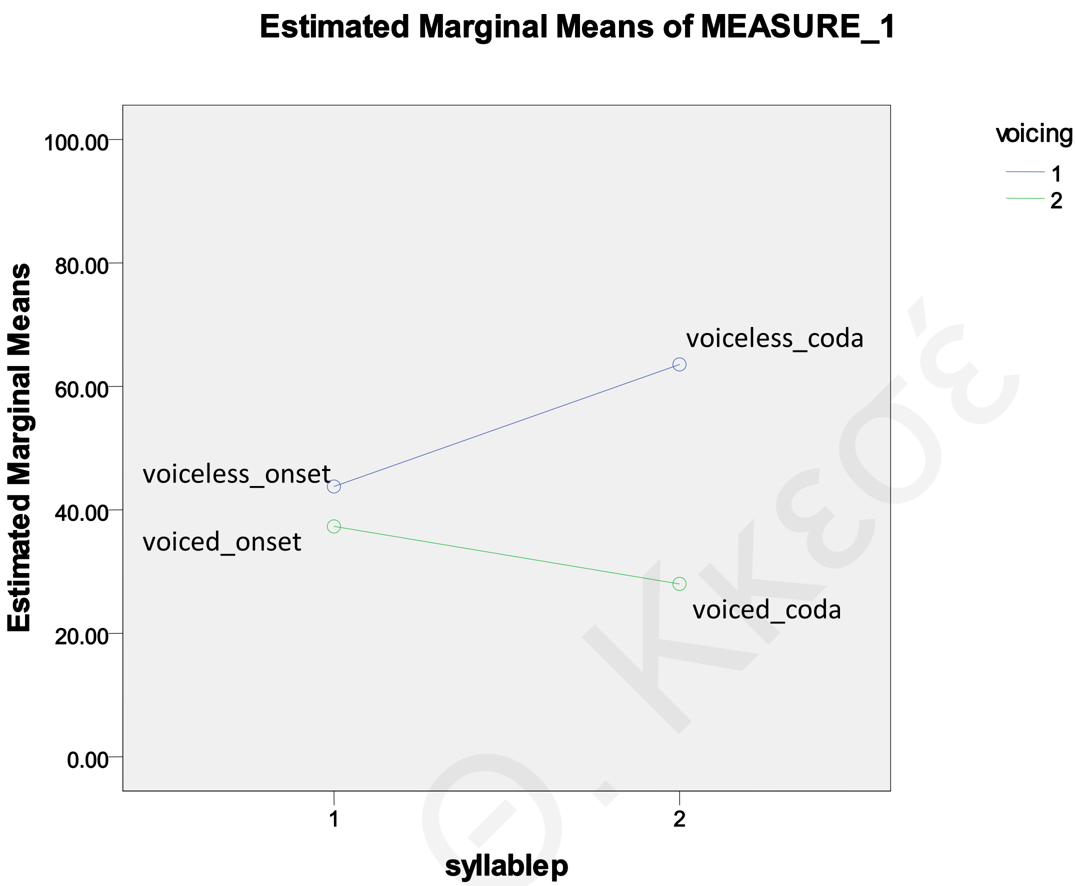

Figure 29: Interaction between syllable position X voicing (better performance in voiceless coda plosives)

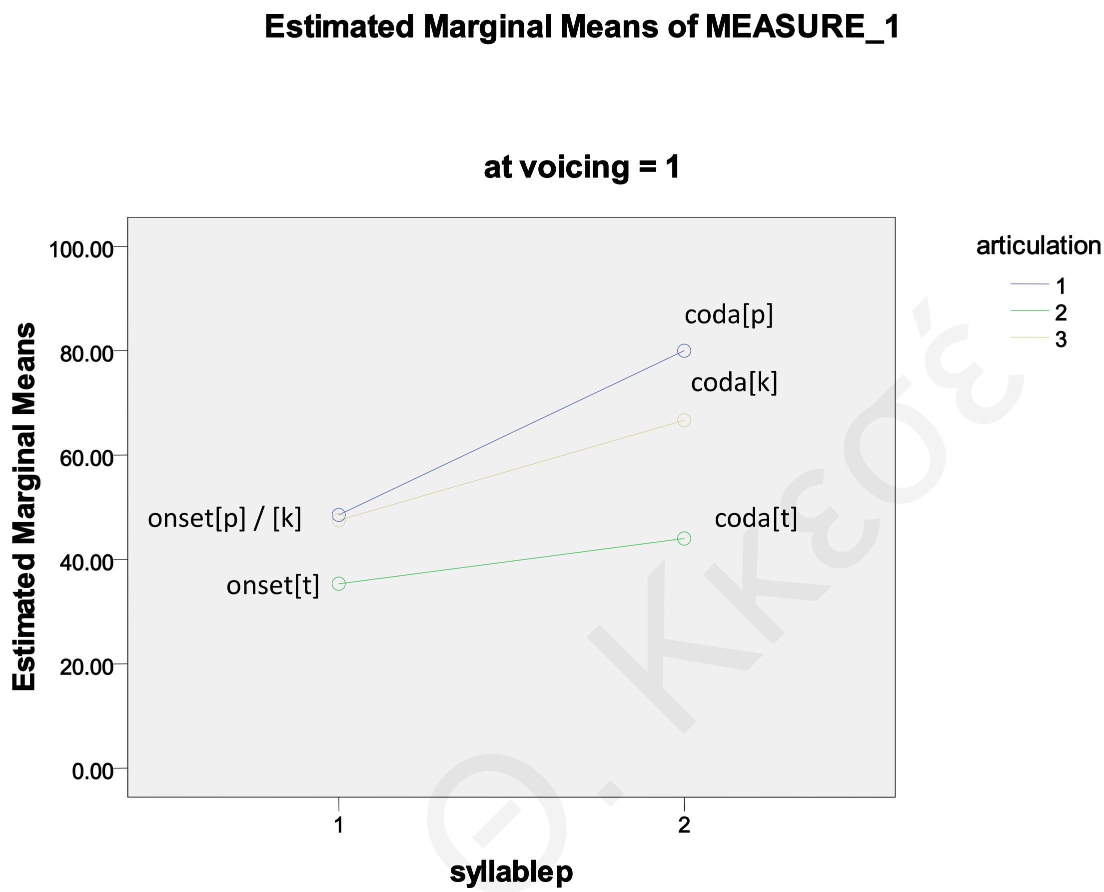

Figure 30: Interaction between syllable position X place of articulation X voicing (better performance in voiceless plosives in coda position)

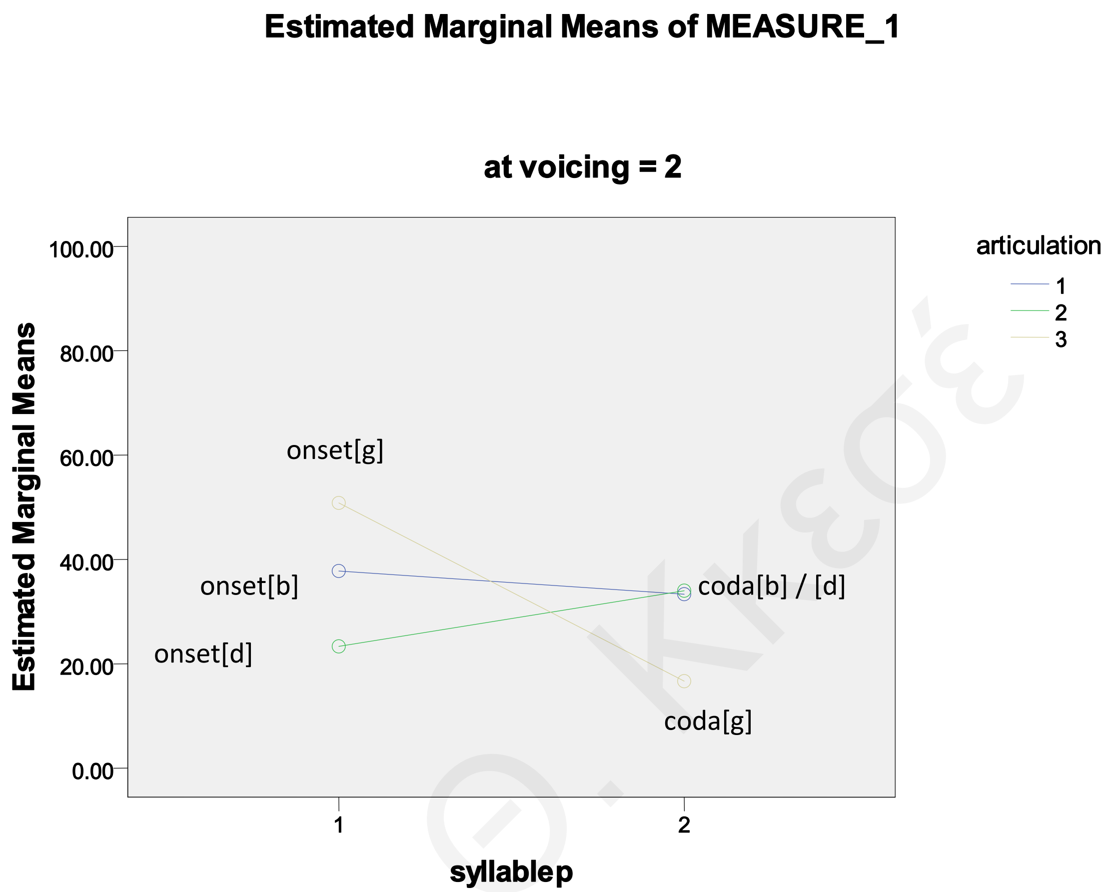

Figure 31: Interaction between syllable position X place of articulation X voicing (better performance in voiced velar and bilabial plosives in onset position)

With reference to utterance position, statistical comparisons as opposed to descriptive statistics could not be performed due to insufficient data. Specifically, data were missing for the majority of the utterance-initial category, with the exception of the utterance-initial [k], as well as for the utterance-final [t] and [k]. The Descriptives output (Table 14) indicates that the highest performance was for utterance-final [p] while for the utterance-medial category participants performed significantly better in perceiving voiceless consonants compared to their voiced counterparts.

	utterance-initial	utterance-medial	utterance-final	N
	M(SD)	*M(SD)*	*M(SD)*	
PPVPA				
Variable1: voiceless bilabial		50.37(20.37)	60.00(49.83)	30
Variable2: voiceless alveolar		39.67(21.25)		
Variable3: voiceless velar	50.00(50.85)	51.48(22.12)		
Variable4: voiced bilabial		33.75(22.54)	51.67(33.43)	30
Variable5: voiced alveolar		27.50(19.53)	33.33(30.32)	30
Variable6: voiced velar		46.67(29.28)	37.78(24.34)	30

PPVPA = Participants' Performance in terms of Voicing and Place of Articulation

% correct

Table 14: Descriptive results for performance of participants in terms of utterance position, voicing, and place of articulation (better performance in voiceless plosives).

Summary for the Words-in-Sentences Identification task

Generally, the second task indicated that a better overall performance was found in voiceless, velar, word-initial, coda plosives. Based on the results obtained from all the MANOVAs conducted, participants performed considerably better in perceiving voiceless plosive consonants than their voiced counterparts. For the second MANOVAs, participants did much better in perceiving plosives in word-initial position, followed by plosives in word-final position while the worst performance was found in plosives in word-medial position. For the third MANOVA, performance was better in plosives in coda position but the effect for syllable position was not significant. Once more, significant interactions were revealed for all the MANOVAs conducted pointing to the importance of the voicing contrast factor and how this factor may interact with the rest of the factors.

Summary for the Word Identification and Words-in-Sentences Identification tasks

Overall, the results obtained from the MANOVAs for two identification tasks are in agreement pointing to the importance of the four examined factors. Both tasks indicated to a better performance for voiceless plosives when compared to their voiced counterparts concerning the voicing contrast factor. As to the place of articulation factor, performance was generally found to be better in velar plosives. Moreover, better performance was manifested in plosive consonants in word-initial category. The only finding that seems to contradict the results obtained for the two tasks involves performance for the syllable position factor. Specifically, for the first task participants did better in plosives in onset position but for the second task they performed better in plosives in coda category (except for voiced bilabial and velar plosives). However, the difference for syllable position concerning the second task was not significant ($F(1,29)=3.01$).

3. Quantitative Results for Research Question 2

The following section presents the results for Research Question 2: What are the types of errors in the second identification task? In order to answer this question, a MANOVA analysis was performed with voicing as between subject factor that enabled the comparison of the voiceless and voiced error types produced by the participants. More specifically, this question addressed the specific perception errors, including substitution and avoidance (avoid giving an answer all together) for each error in Task 2.

3.1. Quantitative Findings: Types of Errors in the Words-in-Sentences Identification Task

For Question 2, the actual written responses given by the participants for Task 2 were analysed in an effort to investigate the extent to which correct and incorrect responses were produced in terms of voicing. From the descriptive statistics (Table 15), it becomes evident that most correct responses involved voiceless plosive consonants (M = 46.13, SD = 17.76) rather than voiced plosives (M = 37.73, SD = 18.96). As a result, participants performed considerably better in perceiving voiceless plosives while when it comes to voiced plosives most of the incorrect responses involved substitutions with voiceless consonants (M = 24.80, SD = 12.36).

	voiceless not prenasalised	voiceless prenasalised	voiced not prenasalised	voiced prenasalised	N
	M(S.D.)	*M(S.D.)*	*M(S.D.)*	*M(S.D.)*	
PPR					
Variable1: correct	46.13(17.76)	6.13(4.67)	37.73(18.96)	22.67(22.73)	30
Variable2: incorrect voiceless	3.87(3.24)	.00(.00)	24.80(12.36)	.67(3.65)	30
Variable3: incorrect voiced	11.20(6.84)	1.07(2.08)	2.40(2.25)	.67(3.65)	30
Variable4: incorrectly prenasalised	.27(1.02)	.00(.00)	.67(1.85)	.00(.00)	30
Variable5: incorrectly not prenasalised	.00(.00)	2.93(3.14)	.00(.00)	8.00(12.43)	30
Variable6: other error	2.80(3.18)	1.33(2.19)	3.47(3.89)	17.33(19.46)	30
Variable7: no response	35.33(20.61)	8.13(4.98)	4.00(.00)	44.00(32.12)	30

PPR = Participants' Performance in terms of the seven types of Responses

% correct, % incorrect

Table 15: Descriptive statistics for performance of participants in terms of correct and incorrect answers (better performance in voiceless plosives).

A between subjects factor Multivariate Analysis of Variance (MANOVA) with two voicing levels (voiceless, voiced) and seven types of responses (one correct and six incorrect) as the dependent variables was conducted in order to compare the effects of voicing. Consequently, the emphasis was given on voiceless and voiced consonants for each type of error.

The MANOVA indicated a significant main effect of voicing for correct responses for prenasalised but not for not prenasalised targets, and six main effects of voicing for incorrect responses. Specifically, there was a main effect of voicing for correct responses for prenasalised target words $F(1,58) = 15.23$, $p < .001$, $\eta^2 = .21$ indicating that participants were more successful at perceiving correctly voiced consonants (*M* = 22.67, *SD* = 22.73) when prenasalised compared to voiceless (*M* = 6.13, *SD* = 4.67). However, the main effects for incorrect responses involved both not prenasalised and prenasalised target words suggesting that participants did much worse when it comes to voiced consonants as compared to voiceless (% of error). Concerning the former (not prenasalised words), the participants instead of the target were providing: 1) an incorrect voiceless consonant $F(1,58) = 80.56$, $p < .001$, $\eta^2 = .58$, 2) an incorrect voiced consonant $F(1,58) = 44.80$, $p < .001$, $\eta^2 = .44$, or 3), or 3) no response at all $F(1,58) = 69.32$, $p < .001$, $\eta^2 = .54$. With reference to the latter (prenasalised words), the incorrect answers could involve: 1) an incorrectly not prenasalised word $F(1,58) = 4.69$, $p < .05$, $\eta^2 = .08$, 2) other consonant(s) $F(1,58) = 20.02$, $p < .001$, $\eta^2 = .26$, or 3) no response $F(1,58) = 36.53$, $p < .001$, $\eta^2 = .39$ (for descriptive statistics, see Table 15).

Specifically, the second main effect (target not prenasalised incorrect voicelesss) indicated that participants performed worse in voiced consonants (*M* = 24.80, *SD* = 12.36) compared to voiceless (*M* = 3.87, *SD* = 3.24) that suggests that voiced plosives are more difficult to be perceived than voiceless ones. Nonetheless, for the third effect (target not prenasalised incorrect voiced), performance was worse for voiceless plosive consonants (*M* = 11.20, *SD* = 6.84) than their voiced counterparts (*M* = 2.40, *SD* = 2.25). Performance was also worse for voiceless plosives with reference to the fourth main effect (target not prenasalised incorrect no response) compared to voiced consonants (voiceless *M* = 35.33, *SD* = 20.61; voiced *M* = 4.00, *SD* = .00). This suggests that in the cases in which the participants avoided giving a written response all together, the target word involved a voiceless consonant rather than a voiced one. The remaining main effects indicated a worse overall performance for voiced plosive consonants. Specifically, for the fifth main effect (target prenasalised incorrectly not prenasalised) participants performed worse when it comes to voiced plosives (*M* = 8.00, *SD* = 12.43) than voiceless (*M* = 2.93, *SD* = 3.14) since more target words involving voiced consonants were incorrectly not prenasalised. The percentage of error was also greater for the sixth main effect (target prenasalised incorrect other) with voiced consonants being perceived more difficult than voiceless (voiced *M* = 17.33, *SD* = 19.46; voiceless *M* = 1.33, *SD* = 2.19). For this type of error, participants were more likely to give a different response (hence ‘other error’) in the case of voiced plosives. Finally, the seventh main effect (target prenasalised incorrect no response) pointed to the same finding (voiced *M*

= 44.00, *SD* = 32.12; voiceless *M* = 8.13, *SD* = 4.98) since most of the no responses referred to voiced prenasalised consonants.

Summary

In this chapter, the results of the data analyses were presented. The data was collected and then processed in response to the problems posed in Chapter 3. Each of the research questions was answered and the methodology used to answer these questions was specified. The study involved quantitative data collected from the two identification tasks that were used to answer Research Question 1 (factors affecting the identification of plosive consonants). Research Question 2 (types of errors) was answered using the quantitative data collected exclusively from the second task. In the next chapter, the results for Research Questions 1 and 2 are discussed in more detail in terms of their relation to previous findings and theoretical models in the fields of L2 acquisition. Further, the findings obtained from the two research questions are put together in an attempt to identify the source of the difficulties that CG speakers face with plosives in the L2 English.

CHAPTER FIVE: DISCUSSION

Introduction

In the previous chapter, a detailed description of the results obtained in the present study for Research Questions 1 and 2 has been provided. It is now time to turn to the discussion of the findings[17] in terms of their relation to previous empirical research, as well as to the approaches of second language phonology and speech perception in an effort to identify the source of plosive difficulties that L2 CG users face. In section 1, the emphasis is on the question regarding the different factors that affect the identification of plosives and the different weight assigned to each of them in the two identification tasks. In section 1.1, an interpretation of this difference is provided and in section 1.2 the similarity of the results to other studies in L1 and L2 acquisition fields is highlighted. In section 1.3, the focus is on the theoretical implications of the findings in terms of second language phonology and speech perception. In the second part of the chapter, section 2, the issue of error types is discussed. Specifically, in section 2.1 an interpretation of the types of errors is provided before turning to the relation of the present findings to previous research in section 2.2. In section 2.3, the theoretical implications of the findings are discussed in terms of the two approaches. In section 3, the source of the difficulties faced by L2 CG users when it comes to plosive consonants in English is identified based on the findings obtained from both the factors affecting plosive identification and the types of errors of the present study. Specifically, the problems with L2 plosives seem to be the result of misperception (at the acoustic level) rather than phonological deficits (at the abstract phonological level).

1. Performance on the Identification Tasks 1 and 2 (Factors identification)

1.1. Interpretation of the Results

Recall that, as was discussed in section 2 (Ch.4), a major concern of the present study, was to identify the various factors affecting plosive identification. This concern was largely due to the hypothesis that the acoustic properties of plosives are said to be affected by phonetic environment leading to systematic variability in the speech signal that can hinder successful lexical access (Klatt 1986, Stevens & Blumstein 1978) and, as a result, successful everyday communication. The results presented in Chapter 4 confirm this hypothesis. The

[17] The discussion of the results follows the sequence of the Research Questions in Chapters 1 and 3.

performance of L2 CG users in the two developed identification tasks was indeed found to be affected by the factors attested. Specifically, four factors were examined for both tasks including voicing, place of articulation, syllable position, and word position while for the second task (Words-in-Sentences identification task), a fifth factor was also examined involving utterance position due to the nature of the task. All factors were found to be significant but different weight was assigned to each of them for the two tasks.

With reference to the first task (Word identification task), both descriptive and inferential analyses were used for identifying how important each factor is when it comes to plosives. The results presented in section 2.1.1. (Ch.4) provide an indication of the rank order for the four examined factors. Specifically, syllable position is identified as having the greatest influence on plosive identification, followed by voicing, word position, and place of articulation for both kinds of analyses. Even though, the word identification task involved a forced choice task that may imply that a choice of 50% for one of the choices corresponds to chance, the fact that the tokens that tested the same voicing contrast were mixed together rather than being in separate blocks and the use of inferential statistics, namely MANOVA, indicated that the participants' answers were not the result of chance performance.

Concerning the three MANOVAs performed for Task 1, the two variables of voicing and place of articulation were included in all the analyses. Specifically for voicing, all MANOVAs indicated a significant main effect of voicing on performance with participants doing considerably better in voiceless plosives compared to voiced ones. On the other hand, place of articulation was more obvious in some interactions and marginal means. For the first MANOVA (voicing X place of articulation), a main effect was identified only for voicing $F(1,112) = 16.50$, $p < .001$, $\eta^2 = .13$ but not for place of articulation, even though there was a significant interaction between the two variables. For the second MANOVA (voicing X place of articulation X word position), a significant main effect was identified for voicing $F(1,112) = 21.60$, $p < .001$, $\eta^2 = .16$ and word position $F(1.8,202.46) = 13.54$, $p < .001$, $\eta^2 = .11$ (Greenhouse-Geisser corrected), as well as an interaction between word position X voicing. Nonetheless, a main effect was not identified for place of articulation while there was no interaction between word position X place of articulation or place of articulation X word position X voicing. Only for the third MANOVA (voicing X place of articulation X syllable position), a main effect was identified for place of articulation $F(2,224) = 3.66$, $p < .05$, $\eta^2 = .03$. Further main effects involved voicing $F(1,112) = 20.76$, $p < .001$, $\eta^2 = .16$ and syllable position $F(1,112) = 30.12$, $p < .001$, $\eta^2 = .21$ as well as an interaction between syllable position X voicing and place of articulation X voicing but not between syllable position X place of articulation X voicing.

Generally, the results of the MANOVAs indicated a better overall performance for voiceless plosives compared to voiced in terms of the voicing contrast. With reference to place of articulation, better performance was manifested in velar plosives, followed by bilabial, while alveolar plosives constituted the most problematic category for the L2 CG users. For syllable position, performance was better for syllable onset plosives rather than syllable coda. Lastly, concerning word position, word-initial plosives were more easily identified, followed by plosives at word-final position while word-medial plosives were the most challenging category.

Concerning the second task, the MANOVAs conducted suggest that voicing was the most influential factor $F(1,29) = 53.01$, $p < .001$, $\eta^2 = .65$ (third MANOVA), $F(1,29) = 46.18$, $p < .001$, $\eta^2 = .61$ (second MANOVA word-medial vs. -final category), $F(1,29) = 20.12$, $p < .001$, $\eta^2 = .41$ (first MANOVA). This was followed by the word position factor $F(2,58) = 30.00$, $p < .001$, $\eta^2 = .51$ (second MANOVA bilabial vs. velar) and $F(1,29) = 25.37$, $p < .001$, $\eta^2 = .47$ (second MANOVA word-medial vs. -final category). The third most important factor identified was place of articulation $F(1.85,53.73) = 17.63$, $p < .001$, $\eta^2 = .38$ (Greenhouse-Geisser corrected for the third MANOVA), $F(2,58) = 14.32$, $p < .001$, $\eta^2 = .33$ (first MANOVA), and $F(2,58) = 3.11$, $p > .05$, $\eta^2 = .10$ (marginal effect for the second MANOVA word-medial vs. –final category). Syllable position was identified as the least influential factor $F(1,29) = 3.01$, $p > .05$, $\eta^2 = .09$. Recall that insufficient data for the utterance position factor did not permit a statistical comparison.

The MANOVAs conducted for Task 2 also indicated a more significant main effect of voicing compared to place of articulation. Only for the first and third MANOVA, place of articulation had a main effect while in most cases the effect was marginal or the variable was found in interactions. For the first MANOVA (voicing X place of articulation), a main effect was identified for voicing $F(1,29) = 20.12$, $p < .001$, $\eta^2 = .41$ and place of articulation $F(2,58) = 14.32$, $p < .001$, $\eta^2 = .33$ but there was no interaction between the two variables. The first MANOVA performed for the second factor (word-medial vs. -final category) indicated main effects for word position $F(1,29) = 25.37$, $p < .001$, $\eta^2 = .47$ and voicing $F(1,29) = 46.18$, $p < .001$, $\eta^2 = .61$ as well as a marginal effect for place of articulation $F(2,58) = 3.11$, p > .05 ($p =$

.05), η^2 = .10. Interactions involved word position X place of articulation, word position X voicing, place of articulation X voicing, and word position X place of articulation X voicing. The second MANOVA conducted for word position (bilabial vs. velar) indicated a main effect for voicing $F(1,29) = 32.71$, $p < .001$, $\eta^2 = .53$ and word position $F(2,58) = 30.00$, $p < .001$, $\eta^2 = .51$ but not for place of articulation. It also indicated an interaction between word position X place of articulation and word position X voicing. No interactions were identified for place of articulation X voicing or word position X place of articulation X voicing. Finally, the third MANOVA indicated a main effect for voicing (1,29) = 53.01, $p < .001$, $\eta^2 = .65$ and place of articulation $F(1.85,53.73) = 17.63$, $p < .001$, $\eta^2 = .38$. but not a main effect for syllable position. Four interactions were identified including syllable position X place of articulation, syllable position X voicing, place of articulation X voicing, and syllable position X place of articulation X voicing.

The small sample size used for Task 2 did not allow a ranking of the investigated factors as in Task 1 (section 2.1.1 Ch.4). Nonetheless, if descriptive statistics ranking the means for all combinations were to be carefully used, the results would have been in agreement with the inferential statistics regarding Task 2 (see Appendix G p. 275).

Overall, the results of the MANOVAs for Task 2 agree with the results obtained for Task 1. Specifically, the MANOVAs for Task 2 indicated a better performance for voiceless plosives when compared to their voiced counterparts concerning the voicing contrast factor. Similarly, for the factor involving place of articulation, the first and second MANOVAs indicated a better performance for velar plosives and then for bilabial plosives (alveolars were not included). Nonetheless, for the third MANOVA, performance was better for bilabial plosives followed by velar and alveolar even though the difference was not that significant. Another finding that contradicts the results obtained for Task 1 involves performance for syllable position that was better for the coda category. The only exceptions involved the voiced bilabial and velar plosives where the participants did better in onset position. However, the difference for syllable position was not significant ($F(1,29)=3.01$). Finally, in terms of word position better performance was manifested in the word-initial category and then in the word-final. The word-medial category appeared to be the one causing several difficulties to L2 CG users except in the case of voiced velar in the first MANOVA conducted for word position (comparing word-medial and -final position). Participants in that case identified more accurately [g] in word-medial position since based on past studies (Ohala & Riordan 1979, Yavas 1993 in Yavas 1994) [g] is the most intrinsically difficult plosive to voice in word-final position.

As a consequence, the results obtained from the two tasks pointed to the importance of the four examined factors. Nonetheless, a different weight was assigned to these factors depending on the task especially for the syllable position and voicing contrast factors. This was probably due to the fact that the sample size used for the second task was smaller compared to the data used for the first task.

Another reason for the different results may involve the design of the two tasks themselves. One obvious question that arises in connection to these results is what would account for the difference in the percentage of correctness for participants in the two tasks. Recall that the major difference between the tasks as they were designed for the present study was that Task 1 involved a purely phonetic identification task while Task 2 also involved writing down what was heard for each pair. Even though participants were not explicitly aware of the contrasts they needed to differentiate in order to succeed in the two tasks and the words included involved low-frequency words, which the users probably heard for the first time, Task 2 had higher attentional demands compared to Task 1. Performance in such tasks (higher attentional demands and no explicit information about the contrasts needed to be differentiated) is usually expected to be worse. Specifically, the performance of the L2 CG users on Task 1 was found to be different from that on Task 2 (Task 1 M = 52.93(18.59); Task 2 M = 38.84(16.00)) based on descriptive statistics. Concerning Task 1, the goal was to test participants' performance in the simple two-way force choice identification procedure. The participants' attention, though, was diverted by the fact that all the tokens that tested the same voicing contrast were mixed together rather than being in separate blocks. Specifically, minimal pairs were presented in two fully randomised blocks to exclude systematic patterning. On Task 2, however, participants had to concentrate on the meaning of the words, the fact that the plosives were mixed together, and that they also had to write down what they heard.

In Task 2, the participants might have made more mistakes compared to Task 1 due to the presence of sentential context (syntax and semantics). Even though sentential context was available to assist listeners in identifying the correct word (or type of word) based on what could make sense in the blanks, several participants conveyed to the researcher-teacher that the sentences confused them and made it harder to identify the plosives and consequently the words. On the contrary, Task 1 involved less competing information compared to Task 2 since it was a phonetics and phonology task and participants could isolate perception.

Another contributing factor might have been that of different treatment of stimuli in terms of lexical processing. Specifically, for Task 1 participants simply had to identify the plosive, even though the task included words and participants were not required to consult their lexicons. Task 2, though, could only be performed by consulting their lexicons directly since participants had to write down what they heard while the presence of sentential context further insured that some lexical activation took place for Task 2.

The heavy reliance on lexical information in Task 2 as compared to Task 1 may suggest that the results of the study can be interpreted as indicating that the CG users had more difficulties differentiating the L2 contrasts in lexical contexts (Task 2) as compared to the simple phonetic task (Task 1). As a result, the presence of lexical processing might have contributed to the higher degree of difficulty that the L2 users experienced on Task 2. This lack of any word frequency effects may have affected the overall performance on the two tasks since word frequency is usually found to be an important factor in word identification. Further, the participants had some 'lead' time to access their lexical representations before they even heard the target word since some words were embedded at the middle or end of the carrier sentence rather than the beginning. This may have obscured any effect of word frequency.

Therefore, the lack of word frequency effect could be explained by the design of the task. Specifically, it would be expected that the more frequent words would have an advantage over the less frequent in terms of the amount of the acoustic cues accumulated over time (Pisoni 1996, Goldinger 1992, Klatt 1981, 1979). This would lead to the better acquisition of the words as compared to the less frequent words heard only rarely. As a result, this may have affected the percentage of correctness of the L2 users in a negative way.

1.2. Relation to Previous Research Findings

By accepting the hypothesis that less successful differentiation of L2 plosives on the part of CG users was partially due to the four investigated factors manifested in Tasks 1 and 2 implies that the specific L2 sounds do not exist or are non-contrastive in the L1. In such case, the results of the present study could straightforwardly be related to the previous research findings in language acquisition as discussed in Chapter 2. Recall that a number of studies suggested that the less successful differentiation of plosive contrasts was the outcome of the investigated factors. Therefore, several studies concentrated on the voicing contrast as the source of plosive difficulties (Chan 2009, Hecht & Mulford 1982, Macken & Ferguson 1981, Repp 1979, Lisker et al.1977, Summerfield & Haggard 1977, Lisker 1975, Stevens & Klatt 1974, Haggard, Ambler & Callow 1970), on place of articulation (Liu et al. 2007, Cho & Ladefoged 1999, Shimizu 1996, Kent & Read 1992, Jakobson & Waugh1979, Klatt 1975, Fant 1973, Lisker & Abramson 1964), on syllable position (Byrd et a. 2005, Keating, Wright & Zhang 1999, Byrd 1996, Summerfield & Haggard 1977, Lisker 1975), and on word position (Cebrian, 2000, Gow, Melrold & Manuel 1996, Gow & Gordon 1995). The present results then contribute to the growing literature on the subject.

In addition, the present study could also be found to have some similarity to certain findings in the field of L1 acquisition. As discussed in Chapter 2, L1 and L2 acquisition appear to be parallel with the performance of L1 children being similar to that of L2 users acquiring novel L2 contrasts later on in life. Specifically, both types of language users seem to be more successful on simple phonetic tasks but face difficulties when it comes to utilise the phonetic contrasts in lexical environments. Nonetheless, even though for L1 children this difficulty is quickly overcome, for L2 users it can last for years (Boersma & Cutler 2008, Major & Faudree 1996, Osburne 1996, Benson 1988, Altenberg & Vago 1987, Broselow 1987, Major 1987a, Tarone 1987, Hodne 1985, Flege & Davidian 1984, Sato 1984, Vago & Altenberg 1977). Nonetheless, the difference between L1 and L2 acquisition is hardly surprising given the malleability of the brain in infancy (Lenneberg 1967) and the fact that L1 users do not experience any interference from the knowledge of L1 or other languages that may affect their weighting of acoustic cues in perception (Holliday 2010).

1.3. Theoretical Implications

Given the effect of the four investigated factors found in the two identification tasks, it is important to assess how this finding could be accounted for in terms of the approaches discussed in Chapter 2. Recall that two major approaches were discussed, second language phonology (section 1) and speech perception (section 2).

Recall that second language phonology refers to a system of knowledge involving more than pronunciation. This mental representation system of the L2 sounds it about what the L2 users know and not just what they can do in the L2. However, linguistic constraints such as the concept of the Critical Period (Lenneberg 1967) carry the inherent suggestion of loss of neocortical plasticity with maturation. In other words, language acquisition becomes increasingly difficult with development (Simmonds, Wise & Leech 2011). As a result, this must impact on the phonological competence accompanying L2 acquisition in terms of its perception and production (Scovel 1969). This is supported with studies comparing early and late L2 users (Alario et al. 2010) in which early L2 users have independent representations for the L1 and L2 but late L2 users use the same representation for the two languages. This suggests that for late L2 users, the representation of L2 depends on their earlier L1 experience including, as a result, non-native L1-like patterns implying that failure to produce L2 speech sounds accurately may be a problem of phonetic implementation (articulation) than a problem of phonological encoding (auditory discrimination of speech sounds). Consequently, this inability to distinguish perception of certain vowels or consonants in L2 that do not exist or are 'phonological ungrammatical' in L1 may result in assimilating these into the closest acceptable form in the L1 (Dupoux et al. 1999). For the purpose of this study, the examination of different factors enabled a close insight into the L2 users' perception of plosives and especially voiced plosives that according to some descriptions of CG do not exist in the dialect or are realised as prenasalised voiced plosives as in [ᵐbaˈᵐbas] (Arvaniti 2006, Kappa 2002, Terkourafi 2001, Newton 1072b). The aim was to examine if this difficulty of L2 users to accurately perceive certain plosives is a problem of articulation due to a representational deficit.

Based on the second language phonology approach, voiceless plosives are acquired before their voiced counterparts (Jun 2007, Jakobson 1941/1968). Even after being acquired, voiced consonants are produced and perceived with more difficulty because vocal fold vibration can only occur when there is an adequate pressure drop and airflow across the vocal folds. This condition, however, is not met in the case of voiced plosives, which renders these consonants less natural and therefore more marked than voiceless plosives with respect to UG (Maddieson 1999, Ohala 1983, Chomsky & Halle 1968, van den Berg 1958). Concerning place of articulation, the order of acquisition includes bilabial, velar, alveolar, palatoalveolar, and dental consonants (Jun 2007, Jakobson 1941/1968). Nonetheless, results from phoneme inventory frequency (Maddieson 1984) suggest that among oral plosives frequency is irrelevant as a markedness diagnostic given the small margin of difference in frequency among bilabial (99.1%), velar (99.4%), and alveolar (99.7%) plosives. With reference to syllable position, onset (consonant before nucleus) seems to be more frequent that coda (consonant after nucleus) since almost all languages have open syllables (CV) but not all languages allow closed syllables (CVC) (Carr 1999). As a result, plosives in onset position can more effortlessly be produced and perceived than in coda position. Further, phonemic contrasts are believed to emerge in word initial position before in other positions (*i.e.* pillow/billow *vs.* cap/cab) suggesting that word initial position is more salient in perception and, as a result, in language processing (Smith 2002) compared to word medial and final positions. Lastly, there seems to be a universal tendency to use a higher pitch in initial position than at the end of an utterance. Even thought there are exceptions as in the case of questions where the pitch raises trough the utterance, this is considered as a marked case produced for a specific reason. Therefore, plosives at utterance initial position are more easily produced and perceived (Cho & Keating 2001, Keating, Wright & Zhang 1999).

Speech perception was the second approach discussed in Chapter 2 involving a series of stages through which acoustic cues are mapped onto linguistic information. In that manner, a ‘meaningless speech input’ becomes a ‘meaningful sequence of discrete events’ (Massaro 2001). Attending to the acoustic cue or set of cues is what helps listeners distinguish members of a phonological contrast. Recall that these cues are available to both L1 and L2 users since both share the same basic auditory function. Nonetheless, L2 contrasts may often be difficult for users to perceive since they may not be skilled at attending to them. Further, phonological contrasts in different L1s may be realised differently (acoustically speaking) that results in some degree of L1 influence on the weighting of acoustic cues in perception of the L2 users (depending on their L1 background). On the other hand, L1 users are able to slowly build perceptual categories by being exposed to meaningful input with no interference from an additional language. As a result, the examination of the different factors provides an indication of whether CG users are able to categorise L2 speech sounds into newly formed L2 phonological categories or whether they simply assimilate L2 speech sounds into existing L1 phonological categories.

Based on the speech perception theory, voiceless plosives are more easily perceived and produced by L2 users even though the various acoustic cues that are available provide equivalent information about the voiceless/voiced distinction (Repp et al. 1978, Dorman, Studdert-Kennedy & Raphael 1977). According to these acoustic cues, voiceless plosives involve a longer VOT production, shorter F1 transitions and/or higher F1 frequency at the beginning of onset, high falling F0 contour, and greater articulatory force or louder burst in terms of aspiration energy compared to their voiced counterparts (Whalen et al. 1993, Ohde 1984, Lisker et al. 1977, Summerfield & Haggard 1977, Klatt 1975, Stevens & Klatt 1974, Haggard, Ambler & Callow 1970). Concerning place of articulation, the role of VOT is further verified (Shimizu 1996, Kent & Read 1992, Jakobson & Waugh 1979, Fant 1973) since velar plosives are produced with longer VOT values while bilabial are associated with the shortest VOT values (Klatt 1975, Lisker & Abramson 1964). Next, plosives in onset position seem to be more easily perceived compared to coda position. Evidence for this is provided with both voicing and place of articulation of plosives. Specifically, for the former, VOT and onset frequency of the first formant are thought to be salient cues for distinguishing between voiceless and voiced plosives while for the latter salient cues involve the release bursts and formant transitions. However, these cues referring to voicing and place of articulation may not occur for plosives in coda position (Summerfield & Haggard 1977, Lisker 1975). Further, plosives in word initial position are not affected by phonological processes as in other positions while they appear to guide word perception in continuous speech (Gow & Gordon 1995). Finally, for plosives in utterance-initial and -final position, constriction formations and release durations are longer (Byrd et al. 2000, Byrd & Saltzman 1998) while larger movement displacements and greater linguapalatal contact are also evident (Keating, Wright & Zhang 1999, Byrd & Saltzman 1998).

2. Performance on the Words-in-Sentences Identification Task (Types of Errors)

2.1. Interpretation of the Results

The second issue discussed in the present study is that of the types of errors exhibited in each of the three plosive pairs. This question was dealt with in Task 2 in which the participants had to write down the words they heard involving the target plosives.

Overall, the participants' results are in line with what was expected. L2 CG users were more successful identifying correctly voiceless plosives (46.13%) rather than their voiced counterparts (37.73) since the former are said to be absent (Okalidou et al. 2010, Kong, Beckman & Edwards 2007, Arvaniti 2007, 1999, Mennen & Okalidou 2006) or are realised differently (Okalidou et al. 2010, Botinis et al. 2004) in CG. Based on the first type of descriptions, since in CG there are no voiced plosives, these are pronounced as their voiceless counterparts or as prenasalised voiced plosives (Arvaniti 2006, Newton 1972a). According to the second type of descriptions, voiced plosives are preceded by other voiced phonemes such as /m/ or /z/ and are followed by a vowel (prenasalised plosives) (Okalidou et al. 2010, Newton 1972b). Therefore, two findings in respect to the types of errors deserve comment.

The most important finding refers to the fact that most of the errors that were made involve voiced plosives that were incorrectly replaced by their voiceless counterparts (24.80%) but not with other voiced consonants (2.40%). However, this was not observed in the case of voiceless plosives that were rarely replaced by other voiceless (3.87%) or voiced (11.20%) consonants. This suggests that voiced plosives are replaced by voiceless ones probably because the former are non-contrastive in the L1. Concerning prenasalisation of voiceless and voiced plosives, this did not point to a significant difference. Specifically, concerning incorrectly prenasalised plosives (*i.e.* 'cap' instead of 'camp'), the difference between voiced (0.67%) and voiceless (0.27%) consonants was not significant while for incorrectly not prenasalised plosives (*i.e.* 'camp' instead of 'cap'), no difference was found (voiceless 0.00%, voiced 0.00%). The category of 'other errors' involving cases in which the students could provide a number instead of the target words (*i.e.* '8' for 'eight') or incomplete words (*i.e.* 'car' for 'cab') also did not point to a significant difference (voiced 3.47%, voiceless 2.80%). Lastly, in the cases in which the participants failed to provide an answer, the target plosives were voiceless (35.33%) rather than voiced (4.00%). Consequently, through this first part, the important points revealed involve L2 CG users' tendency to substitute voiced plosives with voiceless and in the cases in which they were not sure about the voiceless plosive identity, their tendency to avoid giving an answer all together. This indicates that L2 CG users were more confident when it comes to voiceless plosives probably because this category is closer to their L1.

A second important finding involves prenasalisation. Specifically, participants' performance was significantly better in voiced prenasalised (22.67%) compared to voiceless ones (6.13%). With reference to error types, the most noticeable pattern involved avoidance. In the cases in which the participants did not provide any answer, this had to do with voiced prenasalised plosives (44.00%) and not with voiceless (8.13%). Further, a number of other errors was also made for the voiced prenasalised category (17.33%) compared to the voiceless prenasalised category (1.33%). Voiceless prenasalised plosives were in certain cases substituted with voiced prenasalised plosives (1.07%) than with other voiceless plosives (.00) even though the difference was not statistically significant. The second part, thus, points to the

L2 CG users' tendency to substitute voiceless prenasalised plosives with voiced ones and when not sure about a possible answer for a voiced prenasalised plosive, their tendency to avoid providing an answer. This indicates that the L2 CG users tended to use prenasalised plosives rather than voiced plosives, which suggests that the latter are realised differently in CG.

Therefore, the two findings discussed agree with sections 3 and 4 (Ch.2) suggesting that both voiceless plosives[18] and prenasalised voiced plosives are present in CG. On the other hand, voiced plosives (no prevoicing) do not seem to exist in CG unlike English (Carr 1999) and SMG (Okalidou et al. 2010, Arvaniti 2007, 1999, Kong, Beckman & Edwards 2007, Mennen & Okalidou 2006). Plosives in CG, as a consequence, seem to differ considerably when compared to their English counterparts.

2.2. Relation to Previous Research Findings

The findings obtained from the second task suggest that voiceless plosives can be identified by L2 users more effortlessly compared to their voiced counterparts while voiced plosives are more likely to be incorrectly substituted by voiceless consonants rather than other voiced plosives. These results could straightforwardly be related to previous research findings supporting that voiced plosives are more difficult sounds compared to the voiceless ones (Chang et al. 2011, Jun 2007, Kong, Beckman & Edwards 2007, Kewley-Port & Preston 1974). According to Kong, Beckman, and Edwards (2007), 'A truly voiced stop (i.e., one realized with voicing onset before the burst), is a difficult sound because the buildup of supralaryngeal air pressure during stop closure conflicts with aerodynamic requirements of the glottal gesture' (865).

Recall that, as discussed in Chapter 2, a number of studies has examined the issue of the existing voicing contrasts in CG and their corresponding characteristics of VOT. However, this was done in contrast to SMG (Okalidou et al. 2010, Arvaniti 2006, Botinis, Fourakis & Prinou 2000, Viechnicki 1996, Newton 1972a) rather than English but it provided valuable information about the three-way voicing contrast in CG that is said to be acquired later than the two-way contrast in SMG (Okalidou et al. 2010) and probably the two-way contrast in English. These studies concentrated on the voiceless aspirated and voiceless unaspirated

[18] Consonant length (singletons vs. geminates) is a contrastive parameter in CG but not in English and, therefore, was not dealt with in the present study.

plosives indicating that the former category is longer than the latter and this lengthening influences duration and VOT (Tserdanelis & Arvaniti 2001, Arvaniti 1999).

With reference to the tendency of the CG users to use prenasalised plosives rather than voiced ones, this may suggest that the users are able to perceive the difference between a voiceless and a voiced plosive and that prenasalisation is a strategy to deal with the latter category. This strategy is also employed by L1 French children who use voiced sonorants, commonly nasals, before initial voiced plosives to take advantage of voicing continuation (Allen 1985). Further, SMG uses this strategy since voiced plosives can partially be nasalised. Voiced plosives appear to develop from clusters of nasal followed by a voiceless plosive (Arvaniti 1999) and many SMG users 'still produce them as clusters or as pre-nasalised stops in at least some prosodic environments' (Kong, Beckman, and Edwards 2007: 866). This usually happens word-medially for adults even though for children it is also observed word-initially. Children, as a result, employ this language-specific strategy to overcome the relative difficulty of producing the long voicing lead values characteristic of voiced plosives. Therefore, by using this strategy children speaking SMG can acquire the two-way voicing contrast between the ages 2;0 to 2;11 while CG children acquire the three-way voicing contrast of CG only by ages 3;6 to 4;0 (Okalidou et al. 2010: 22). Consequently, the late acquisition of voiced plosive in certain languages should 'be understood in terms of specific articulatory and aerodynamic requirements. That is, voiced stops are late only if the phonetics of the language precludes a strategy such as nasalization during closure to overcome their more difficult aerodynamic requirements' (Kong, Beckman & Edwards 2007: 868).

2.3. Theoretical Implications

At this point, it seems appropriate to examine the relative difficulty of CG users with voiced plosives in English in terms of the approaches of second language phonology and speech perception.

According to Jakobson's theory of implicational universals (1941/1968), voiceless unaspirated plosives are acquired first while the acquisition of voiced or aspirated plosives implies the acquisition of voiceless unaspirated ones. Studies on English and Spanish children (Eilers, Oller & Benito-Garcia 1984, Macken & Barton 1980a, b) and babbling of English and French infants (Whalen, Levitt & Goldstein 2007) indicate that they first use unaspirated voiceless plosives. Further, cross-linguistic evidence has indicated that unaspirated voiceless plosives are produced in babbling at 7-8 months (Macken & Barton 1980a), aspirated are acquired around the age of 2 years (Macken & Barton 1980a, Gandour et al. 1986), and voiced plosives are acquired around the age of 4-5 years in French, Thai, and Hindi (Macken & Barton 1980b, Allen 1985, Gandour et al. 1986, Davis 1995). L2 research has also indicated that L2 users may be more accurate when it comes to voiceless plosives than voiced ones (Chang et al. 2011). Examples of such cases are L1 Japanese and Korean speakers who performed better in voiceless plosive-initial onset clusters than voiced ones (Broselow & Finer 1991, Eckman & Iverson 1993) and L1 Mandarin speakers who were more accurate with voiceless coda plosives than voiced ones even though Mandarin is a language that does not permit plosives in codas (Broselow, Chen & Wang 1998).

Kewley-Port and Preston (1974) suggest that this universal order of acquisition 'is phonetically grounded in that the aerodynamic requirements (i.e. timing of oral release and glottal adduction) of voiceless unaspirated stops are easier to satisfy than those of voiced or aspirated stops' (in Jun 2007: 51-52). Whereas a voiceless unaspirated plosive can be produced with adducted glottis, a voiced plosive needs a precise degree of glottal abduction and an adequate difference between subglottal and supraglottal pressure in order to be produced (Kong, Beckman & Edwards 2007). As a result, in order to produce a negative VOT, 'the speaker must either expand the supralaryngeal cavity or loosen the oral or nasopharyngeal seal to leak off some air pressure from the oral cavity in order to maintain vocal fold vibration as supraglottal pressure builds up' (Kong, Beckman & Edwards 2007: 865).

Consequently, for the speech perception theory, VOT is of crucial importance for separating phonemic categories in languages even though these languages may differ in the number of phonological categories and in the phonetic features assigned to them. Specifically, investigation has revealed that there are three patterns for VOT production. These involve the long voicing lead in which phonation begins before the oral release (voiced plosives), the short voicing lag in which phonation begins just after the oral release (voiceless unaspirated plosives), and the long voicing lag in which phonation begins after the oral release (voiceless aspirated plosives). In English, short versus long lag times is the feature that differentiates the voiced-voiceless pairs of word-initial plosives (Lisker & Abramson 1964).

Macken and Barton (1980a) proposed an age independent three-stage model for the development of plosive production by studying four monolingual children at two weeks intervals staring around the age of 1;6 for eight months. Their longitudinal study focused on the acquisition of the voicing contrast in American English word-initial plosives since English is a language that has two voicing categories (voiced-voiceless). Based on the children's plosive productions of single-syllable or two syllable words with initial syllable stress, the first stage proposed involves children producing short-lag plosives (voiceless unaspirated plosives) not being able to produce any contrasts. The second stage involves children differentiating between voiced and voiceless plosives. However, the VOT values are not adult-like. Finally, the third stage involves children distinguishing between voiced and voiceless plosives but the latter category is produced with a longer VOT compared to adults. Adult-like voicing occurs by age 1;9 even if one child in the study did not control VOT until much later and specifically by 2;6. Children's inability to produce long-lag VOTs is attributed to production constraints since children are able to perceive the differences in lag duration for voiced-voiceless English initial plosives from a very early age and specifically as young as two months of age (Eimas et al. 1971, Werker & Tees 1999).

When it comes to L2 users, though, perception of length differences (voiceless vs. voiced) may only be partially successful as Enomoto (1992) suggests by examining L1 English speakers of Japanese. L2 users' difficulties can be attributed to the fact that they are probably not skilled at attending to the cue or set of cues that can reliably discriminate the members of an L2 contrast. This inability to correctly perceive L2 contrasts has been stressed in a number of studies (Broselow 2009, Kang 2003, Peperkamp & Dupoux 2003, Brannen 2002, Hancin-Bhatt 2000, Silverman 1992). Further, L2 users are expected to exhibit some degree of L1 influence on the weighting of acoustic cues in perception (Flege, McCutcheon & Smith 1987). Consequently, L2 contrasts that involve two speech sounds that can be assimilated to an L1 phonological category constitute the most difficult challenges for L2 users.

3. *CG users' difficulties with L2 plosives: the result of IL theory or speech perception theory*

So far, a detailed account of the results of the present study has been provided in relation to previous research in the areas of L1 and L2 acquisition. Nonetheless, the results obtained from the identification of the different factors (tasks 1 and 2) and types of errors (task 2) were not put together in order to provide a convincing justification for the difficulties faced by CG users when it comes to plosives in English. This section, thus, deals with the actual source of the plosive difficulties faced by L2 CG users of English based on the findings obtained from both the factors affecting plosive identification and the types of errors of the present study.

Recall from section 1 (Ch. 2) that second language phonology is an area that has generated several theoretical models (Tarone 1982, Adjemian 1976, Selinker 1972) and numerous theoretical frameworks in the field of L2 acquisition of phonology have been proposed (structuralism, classical phonemics, Contrastive Analysis, generative phonology, natural phonology, non-linear approaches, connectionism, Optimality Theory). Despite the different account that these models and frameworks may provide, however, what becomes evident is that L2 users seem to be 'multicompetent' since there is knowledge of more than one language in the same mind (Cook 1992). This 'multi-competence' includes the L1, the IL (interlanguage), and other aspects of the L2 user's mind (Cook 1992). This suggests that L1 transfer is not a sufficient explanation for the process of L2 acquisition even though it is a major process influencing second language phonology. The influence of L1 seems to decrease as L2 users become more proficient in the target language while the influence of developmental factors increases.

Using a purely constraint-based approach within the framework of OT attempts to provide an explanation for both the universal and transfer processes. According to OT, constraints are universal but the phonologies of languages may differ as to how they rank these constraints (constraint hierarchy) and the fact that constraints may be contradictory, with the one that is ranked higher having priority (Broselow, Chen & Wang 1998). As a result, a constraint may be important in one language but not in another. OT determines what the output form for any given input form must be from an infinite set of output forms. Two forces are responsible for determining which output form is chosen by a specific language. These involve faithfulness referring to the force that tries to make the output form identical to the input form, and the unmarked way of pronouncing. The output form depends on the interaction of these forces. Each force is represented by a set of universal constraints, which every language ranks in its own way. In the case in which the faithfulness constraints are ranked above the phonological constraints, no phonological adjustments are made to the input form. Nonetheless, if the phonological constraints are ranked above the faithfulness constraints, the phonological constraints will predominate. After the constraint hierarchy inspection, only one form will be left. Adult L2 users at the beginning of the phonological acquisition are influenced by the L1 constraint ranking while the input may lead to the re-ranking for some of these constraints.

Describing the second language phonology of L2 users as a set of ranked universal constraints (OT) can account for some of the plosive difficulties encountered by CG users. Based on this account, L2 CG users evaluate a set of possible surface representations corresponding to a given input against the surface constraints of the L1. The ranking of these constraints for the introductory-level students participating in the present study are as in the L1. Interpreting the results of the present study as the outcome of second language phonology may explain the better performance of the L2 CG users in voiceless, word-initial, syllable onset plosives since '[…] syllable onsets and word–initial syllables have been shown to have special licensing properties that allow them to assume perceptual prominence and remain impervious to neutralization effects that occur in weak positions' (Shea and Curtin 2006: 124).

Second language phonology, though, seems to fail to account for the better performance in velar plosives (tasks 1 and 2), which is probably the strongest argument and one of the important findings of the study, while the use of the strategy of prenasalisation (task 2) seems to be the result of L1 transfer. Specifically, better performance in velar plosives seems to provide evidence for the speech perception approach, which suggests that velar plosives are produced with longer VOT values compared to bilabial and alveolar plosives (Klatt 1975, Lisker & Abramson 1964). Based on the speech perception approach, VOT is a robust acoustic cue that seems to determine the place of articulation of plosive consonants. With reference to prenasalisation, this strategy may also provide evidence for the speech perception approach since L2 users are expected to exhibit some degree of L1 influence on their weighting of acoustic cues in perception. Prenasalisation, as a result, seems to be selected due to the L1.

Recall that voiced plosives seem to be absent or realised differently in CG (prenasalised plosives). Consequently, voiceless plosives are more easily identified since this category also exists in their L1 while voiced plosives are substituted with L1 sounds that most closely resemble them in place and manner of articulation and which the participants could perceive based on their knowledge of the L1 phonetic inventory (Carlisle 1994, Weinreich 1953, Eckman 1977). Moreover, as discussed in section 3 (Ch. 2) plosives in CG are present in onset position rather than in coda since the only consonants that can occur in coda, word-final position are [s, n] with the exception of loanwords which are, however, numerous and frequent. As a result, when L2 users are presented with voiced plosives in such positions, they are more likely to use the voiceless consonants instead. This indicates that L2 CG users transfer their L1 knowledge in L2 acquisition that suggests that the former may prevent the full acquisition of the L2 plosive system (Chang, Hong & Halle 2007, Gonet & Pietron 2005, Keys 2002, Flege, Bohn & Jang 1997, Flege 1989).

Further, based on the second language phonology approach, L2 users were expected to perform better in bilabial plosives rather than in velar or alveolar plosives. Specifically, concerning the place of articulation, front consonants are acquired before back consonants. This implies that bilabials are acquired before alveolars and alveolars before velars (Sekiyama & Tohkura 1991, Stemberger & Stoel-Gammon 1991) since greater articulatory complexity correlates with increased markedness. However, the overall performance of the CG users indicated that performance was better in velar plosives, which is one of the important findings of the study, except in one instance regarding the second task where performance was better in bilabial but the difference was not statistically significant (third MANOVA bilabial M = 49.91, SE = 3.87, velar M = 45.42, SE = 3.65). Through the second task, the strategy that was evident was prenasalisation since the L2 CG users seemed to prenasalise plosives in the case they could not identify them as voiceless. This strategy was only obvious for voiced plosives but cannot be accounted in terms of the second language phonology since it violates the proposed universal rankings (OT). Prenasalised plosives would violate the sonority sequencing were they separate segments (*i.e.* anchor-anger).

Therefore, the results cannot be explained adequately in terms of OT while the second language phonology approach cannot account for the better performance with velars in formal phonological terms. Speech perception approach may provide a second, more convincing, alternative. This approach stresses the importance of the auditory system that is responsible for what listeners can or cannot hear, the cues that are recoverable in particular segmental contexts, and the influence of the adjacent sounds. In the case of the L2 users, the theory suggests that listeners are more likely to hear sounds that they are familiar with as talkers since the L1 seems to determine the categorical perception boundaries. This may result in weighing the acoustic cues to phonological contrasts differently from the L1 speakers of the language in question in both production and perception.

With reference to plosives, the spectral characteristics of the burst and the formant transitions seem to be the acoustic cues that are of crucial importance (Cooper et al., 1952, Delattre, Liberman & Cooper 1955, Blumstein & Stevens 1979, Kewley-Port 1982, Smits, ten Bosch & Collier 1996). Voiceless plosives are identified in terms of bursts (Smits, ten Bosch & Collier 1996) while voiced plosives are identified in terms of formant transitions since bursts may often be weak cues even though they can improve performance (Stevens & Blumstein 1978). Nonetheless, the spectra of plosives may depend on the context such as the adjacent vowel while VOT, the delay of voicing onset following a plosive release burst, may also differ based on context. Specifically, voiceless plosives in English were reported to have VOT values of 58ms, 70ms, and 80ms in isolation, and 28ms, 39ms, and 43ms in sentences (Lisker & Abramson 1964). Regarding the voiceless-voiced distinction, voiceless plosives are thought to have VOT values longer than some boundary value while plosives with VOT values that are shorter than the boundary value are considered to be voiced. Lisker (1986) summarised all the acoustic cues for the voicing distinction for English plosives (Table 16).

During consonant	Duration of closure Duration of glottal signal Intensity of glottal signal
Before consonant	Duration of vowel Duration of first-formant (F_1) transition F_1 offset frequency F_1 transition offset time Timing of voice offset Fundamental frequency (f_0 contour) Decay time of signal
After consonant	Release burst intensity Timing of voice onset (VOT) Onset of F_1 transition F_1 onset frequency F_1 transition duration f_0 contour

Table 16: Acoustic cues for voicing distinction for English plosives

Consequently, speech perception can account for the data of the present study since it suggests that L2 CG users must have perceived voicing even though their L1 has no voiced plosives (not a contrastive feature). Nonetheless, because the weighting of auditory cues in the categorisation of plosives is language-specific, L2 users were modifying their identification of voiced plosives to fit the L1. VOT also provides important information to the voiceless-voiced distinction and explains the participants' better performance in voiceless plosives compared to their voiced counterparts as well to word-initial, syllable onset plosives in both the Word- and the Words-in-sentences identification tasks. VOT cues seem to be present in word-initial, syllable onset positions and absent in word-final, syllable coda positions (Giavazzi & Cho in preparation, Cole, Jakimik & Cooper 1978) while in sentences the VOT cues are not that robust (Sato 2011) that explains the fact that L2 CG users performed worse in this task. Lastly, the speech perception theory can also explain the better performance of the L2 CG users in velar consonants compared to their bilabial and alveolar counterparts since velar plosives are associated with significantly longer VOT values than the other plosive consonants (Ng et al. 2011, Liu et al. 2007, Lisker & Abramson 1964).

VOT cues can also account for the strategy of prenasalisation since VOTs are more difficult to produce in the lead voicing region (voiced plosives). As already mentioned, prenasalisation seems to be one of the potential 'enhancement' strategies, which is selected due to the L1. Since sustaining voicing during a plosive is generally difficult, '[l]owering the velum during the stop closure allows air to be vented through the nose, slowing the build up of oral pressure, and thus facilitating voicing. In addition, voicing during an oral stop is radiated only through the neck and face, resulting in a low intensity acoustic signal, whereas lowering the velum allows sound to be radiated from the nose, resulting in greater intensity'. (Flemming 2005: 165). Contrasts between voiceless and prenasalised plosives rather than voiced plosives exist in a number of languages including Mixtec (Iverson & Salmons 1996), Southern Barasano (Smith & Smith 1971), and Guaraní (Gregores & Suárez 1967) among others (Herbert 1986).

Taken together, the results of the present study indicate that when dealing with contrastive L2 categories, the acoustic cue of VOT is of crucial importance (Table 17) since it can account for the better performance of the participants in the voiceless, velar, word-intial, onset plosives as well for the strategy of prenasalisation. Therefore, the results suggest that the CG difficulties with L2 plosives are a speech perception issue (phonetic effect) after all rather than a second language phonology issue (phonological deficit). Nonetheless, the approach of second language phonology and the studies reviewed in Chapter 2 (section 1), even though they did not provide much evidence of the issue, led to the formation of certain expectations. These involved better performance in voiceless, bilabial, word-initial, onset plosives. The results, though, did not provide evidence for articulatory effects. Better performance was not found for bilabial plosives while second language phonology could not adequately account for the strategy of prenasalisation either.

SPEECH PERCEPTION DIFFICULTIES	
Interpreting the results as the outcome of IL phonology implies that…	**Interpreting the results as the outcome of speech perception implies that…**
1) *Distinguishing members of an L2 phonological contrast may be because of transfer and language universals. This:* a) **Can** explain the better performance in voiceless, word-initial, syllable onset plosives b) **Cannot** explain the better performance in velar plosives (better performance expected in bilabials) c) **Cannot** explain the strategy of prenasalisation (violation of the proposed universal rankings)	2) *Distinguishing members of an L2 phonological contrast may be because L2 users are not skilled at attending to the correct acoustic cues. This:* a) **Can** explain the better performance in voiceless, word-initial, syllable onset plosives (VOT cues) b) **Can** explain the better performance in velar plosives (longer VOT values) c) **Can** explain the strategy of prenasalisation selected due to the L1 (VOT cues more difficult to produce in voiced plosives)

Table 17: Speech perception difficulties

Consequently, not being able to differentiate between members of an L2 phonological contrast (*i.e.* voiceless-voiced plosives) may be due to the fact that L2 CG users are not skilled at attending to the correct acoustic cues and especially the acoustic cue of VOT. According to Reis, Nobre-Oliveira, and Rauber (2007), this length of time is 'decisive for accurate perception of the voiceless and voiced stops /p, t, k/ and /b, d, g/ respectively, which characterize the aspirated and unaspirated distinction' (1). As a result, attributing the difficulties of L2 CG users with plosives in English to acoustic differences and specifically difficulties with VOT indicates that L2 CG users have difficulty in perceiving the precise voicing features of English plosives. This seems to lead to the conclusion that speech perception is the actual source for the plosive difficulties rather than representational deficits. Even though the second language phonology approach appears attractive, it fails to take into consideration the fact that distinguishing members of an L2 phonological contrast may simply be because L2 users are not skilled at attending to the correct acoustic cues. According to the second language phonology approach, these difficulties that L2 users face are mainly attributed to transfer and language universals. Nonetheless, acoustic cues are quite important for recognising and categorising particular sounds such as plosives.

Summary

In this chapter, the most important findings obtained in the present study have been discussed. Specifically, the four different factors affecting L2 plosive identification exhibited on the two tasks and the two main types of errors involving plosives manifested in the second task have been addressed. This was done in an effort to attribute the plosive difficulties encountered by CG users concerning the specific L2 phonological contrasts as an effect of phonological deficits or speech perception effects. Even though second language phonology can provide a justification for some of these difficulties, it seems that the obtained results agree mostly with speech perception. In the next chapter, the overall conclusion, together with implications for language pedagogy and recommendations for future research, is presented.

CHAPTER SIX: CONCLUSION

Introduction

This chapter summarises the main findings concerning the perception of plosive consonants in L2 English by CG users. As indicated in the previous chapter, the perception of plosives is influenced by several linguistic factors and especially by the voicing contrast factor. Further, the CG users tended to frequently substitute L2 voiced plosive consonants with prenasalised plosives, which is a strategy employed in their L1. In this chapter, the overall conclusion of the study is addressed and, based on the results, pedagogical implications are provided. Finally, suggestions for future research are made.

1. Overall Conclusion

The present study was designed to test two main questions, 1) that of the different factors affecting L2 plosive identification (Tasks 1 and 2), and 2) that of the error types involving plosive consonants (Task 2). This was done in an effort to attribute the difficulties of CG users with L2 plosives to either representational deficits or speech perception difficulties.

With respect to the first question, the study has indicated that plosive identification was systematically affected by voicing, syllable position, word position, and place of articulation. Specifically, L2 CG users were more accurate in identifying voiceless, syllable onset, word-initial, velar plosives. Through both the descriptive and inferential analyses, it was revealed that the voicing contrast factor was the most influential affecting most of the other factors for both tasks. Even though syllable position was found to be the most important factor for Task 1, the same result was not manifested in Task 2 since this factor was found to be the least influential based on the analyses. Word position and place of articulation were the factors following for both tasks while place of articulation was more obvious in some interactions and marginal means. On the contrary, the voicing contrast factor maintained its influence for both tasks.

With respect to the second question, it was pointed out that most error types involved replacing L2 voiced plosives. Specifically, in the cases in which the target word involved a voiced plosive, participants were more likely to substitute it with its voiceless counterpart while in the cases in which the target word involved a voiced plosive preceded with a nasal consonant, L2 users were correctly identifying the /nasal+voiced plosive/ cluster (prenasalised plosive). This reveals that the L2 CG users were having less difficulty perceiving prenasalised plosives since this strategy also exists in their L1. However, the same pattern was not observed for voiceless plosives, which were more accurately perceived.

Consequently, the results from both tasks point in the same direction with regard to the voicing contrast factor. It seems that the answer to the difficulties faced by L2 CG users probably lies in the voicing contrast that appears to be the real problem as revealed by most of the factors and types of errors involving plosives. The combined results from the tasks seem to provide evidence that the L2 CG users are more successful in voiceless plosives while they treat voiced plosives as underlying sequences of a /nasal+voiced plosive/. These findings reflect the phonological system of plosives in the L1 in which voiced plosives are thought to be absent or are realised as prenasalised plosives stressing the important role of the L1 background in the L2 acquisition of phonology. As a result, when dealing with plosive-voicing distinctions, VOT appears to be an important cue for the perception of voicing (and aspiration) in plosives since L1 CG and L2 English plosives differ with respect to VOT values. Specifically, VOT values for voiceless and voiced plosives in English were reported to be [p] = 58, [b] = 1, [t] = 70, [d] = 5, [k] = 80, [g] = 21 (Lisker & Abramson 1964) while VOT values for unaspirated and aspirated voiceless plosives in CG were reported to be [p^h] = 55, [p] = 5, [t^h] = 60, [t] = 17, [k^h] = 65, [k] = 22 (Tserdanelis & Arvaniti 2001, Arvaniti 1999).

Even though L2 CG users are able to attend to language-specific VOT differences, yet they seem to integrate the L1 and the L2 into a common phonetic and/or phonological space that is influenced by the L1. This is at least true for L1 users and non-proficient L2 users and theoretical models such as PAM (Best 1995) and SLM (Flege 1995), described in Chapter 2, can account for the perception abilities of such users even though they fail to account for more proficient L2 users. Both PAM and SLM suggest that the perceived relation between L2 sounds and their closest L1 counterparts is of crucial importance for predicting discrimination accuracy of sound contrasts in the L2. Their only difference involves the levels at which categories are created or merged. According to PAM, this happens both at a phonetic and a phonological level while SLM suggests that this occurs at a phonetic level. Consequently, for the introductory-level students of the present study, VOT of CG and English seems to collapse that results in having the same category for voiceless and voiced plosives while /nasal+voiced plosive/ clusters are treated as prenasalised plosives just like their L1. Therefore, the results of the present study seem to agree mostly with the speech perception theory suggesting that the

CG users' difficulties with L2 plosives in English are due to VOT differences (reflecting the language-specific VOT settings of the CG).

A final key finding is the differential performance on the two tasks. Participants did significantly better in the task that involved no lexical involvement (Task 1) than in the task where more involvement from the lexicon was necessary (Task 2). Studies dealing with this issue confirm the obtained results (Broesma & Cutler 2008, Broesma 2005). Therefore, differential performance on several tasks may provide valuable information concerning the understanding of the L2 acquisition process.

2. *Pedagogical Implications*

The results of the present study have important pedagogical implications for the teaching of the English language in Cyprus, especially for the area of pronunciation teaching.

Being aware of the differences between plosives in the L1 and the L2 can assist CG users perceive and produce the plosive consonants in the L2 English more accurately. Both the previous literature and the present study indicated that L1 interference has a crucial role in the L2 acquisition of the plosive system (and probably the consonant and vowel systems in general).

Therefore, introducing L2 CG users to the English plosive consonants by explicitly teaching them the place of articulation and the method of producing them can be very useful especially for beginning or low ability L2 users. This would lead the L2 users to perceive and produce L2 plosives accurately rather than depending on their L1 phonetic inventory. Instructors can point to the most important problematic pronunciations of the L2 CG users and clarify their mispronunciations concentrating on the differences of the L2 plosives from the plosives in the L1.

Further, more emphasis should be given on developing the competence of the L2 CG users concerning the identification of plosives (or other problematic sounds). This can be achieved through several perception tasks in which the target sounds are located in different word positions and phonetic environments. The results of the present study indicated that L2 users had difficulties identifying plosives in the low-frequency words used. This suggests that perception practice with plosives is needed in unfamiliar contexts.

The findings regarding the factors affecting plosive identification and error types involving plosives can actually help instructors understand what makes perception and, as a result production, difficult for L2 CG users and in this manner help the L2 users overcome these difficulties. This can further help L2 users to remedy their problematic perception and production. Specifically, L2 CG users were found to have more difficulty perceiving voiced, syllable coda, word-medial, alveolar plosives. Therefore, instructors could focus on the most challenging categories when teaching. Practice with L2 plosives in text (Task 2) is also needed since L2 CG users appeared to have less difficulty perceiving words in isolation (Task 1).

Taken together, problems with challenging sounds for CG users such as plosives in L2 English seem to be overcome with explicit instruction and ample practice in different situations. Consequently, for the context under investigation, further possible problematic sounds need to be identified in order to assist L2 users perceive and produce these sounds accurately.

3. *Future Directions*

The main purpose of the present study was to examine the CG users' perception of plosives in L2 English with respect to the attested factors and perception errors. Several observations were made through the data collection, data analyses, and interpretation of results that need further investigation in future research. The important recommendations are summarised as follows:

First, the present study concentrated on plosive consonants in L2 English in a word- and sentence-level. Consequently, one issue that needs to be addressed in future research is whether a purely phonetic task involving only syllables such as an ABX test produces different results (Broesma & Cutler 2008, Broesma 2005) when compared to the tasks of the present study. Such a task involves no lexical involvement but for practical reasons it was not possible to conduct this kind of test without compromising the ability to compare the results of the two tasks used directly. Nonetheless, the use of low-frequency words in the two tasks aimed at eliminating lexical involvement (especially for Task 1).

Second, the behaviour of plosives (and consonants in general) seems to be sensitive to phonetic environment such as the surrounding phonemes. Specifically, adjacent phonemes, both preceding and following, may function as reliable cues for voicing (Mann 1980) and place of articulation (Repp & Mann 1978, Dorman, Studdert-Kennedy & Raphael 1977, Kunisaki & Fujisaki 1977, Fischer-Jorgensen 1954, Cooper et al. 1952). Further research can, thus, examine the perception of plosives when occurring in different phonetic sequences. For the present study, this was not possible since the acoustic dimension (*i.e.* VOT, plosive closure duration, vowel duration) that often distinguishes voiceless and voiced plosives manifested in the adjacent phoneme factor was not measured.

Third, a factor that also needs to be studied involves the influence of stress on the perception of plosive consonants. Stressed syllables are thought to be more accurately perceived than unstressed syllables especially for syllable-initial voiceless plosives due to aspiration. Nonetheless, due to insufficient data concerning stress, this factor was not possible to be examined for the purpose of the present study.

Fourth, words occurring at the beginning or end of an utterance are believed to be longer and less likely to be reduced than utterance-medial words (Bell et al. 2003). Therefore, it would be interesting to see in which position in an utterance plosives are more effortlessly perceived. In the context of the present study, the researcher had difficulty in making such a comparison of all the phonemes under study across all utterance positions due to lack of data for some phonemes particularly in utterance-initial position. Nonetheless, a descriptive analysis was conducted for utterance-medial and -final positions indicating that L2 CG users performed better in utterance-final position compared to utterance-medial position.

Fifth, the findings of this study reveal that the L2 CG users had less difficulty identifying the plosive consonants in Task 1 than in Task 2. This suggests that the context of situation as presented by the two tasks had a significant bearing on the participants' perception of a particular phoneme. Words in isolation were more easily identified than words presented in sentences. However, further research on this issue is needed since, as already discussed, Task 2 involved a smaller sample size than Task 1.

Sixth, the need for examining CG users' production of English plosives also becomes evident. In that way, it can be investigated whether the same factors affect plosive identification in production and whether L2 CG users proceed to the same error types involving plosives as they did for the present perception study.

Seventh, other possible problematic sounds, including English vowels that do not exist in CG need thorough examination in future research. L2 CG users frequently have difficulty in discriminating and producing long and short vowels since their L1 has a simple system of five vowels while English has a more complicated vowel system. Specifically, the vowel system of

English involves twelve monophthongs and eight diphthongs while monophthongs are further divided into short and long vowel sounds. Therefore, it would be interesting to see how CG users of L2 English perform in terms of the L2 vowels.

Finally, it would be interesting to see how fluent, advanced CG users of L2 English perform in the two tasks used for the present study. Recall that the participants for the purpose of this study were introductory-level students (not advanced). Fluent L2 users, though, are believed to have developed L2 phonetic categories in contrast to non fluent L2 users who can poorly discriminate L2 contrasts due to L1 interference. Therefore, by examining the perception of fluent L2 users, it would be indicated whether there are important differences between the two groups of L2 users.

Summary

This chapter focused on the overall conclusion drawn from the present study suggesting that the difficulties faced by CG users when it comes to L2 plosives in English are due to VOT differences (reflecting the language-specific VOT settings of the CG). As a result, the conclusion seems to agree mostly with the speech perception approach rather than the second language phonology approach. The chapter also contained a number of implications for pedagogy and especially for pronunciation teaching of L2 plosives (or other possible problematic sounds) while in the last section recommendations for future studies were made.

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APPENDICES

A CG Difficulties with L2 plosives

B Word identification task – Version 1

The following pairs of words form minimal pairs that differ in only one sound. Listen and circle the word (a) or (b) that you hear being pronounced.

1	(a) pacing	(b) basing
2	(a) towering	(b) dowering
3	(a) crammer	(b) grammar
4	(a) etching	(b) edging
5	(a) squat	(b) squad
6	(a) coast	(b) ghost
7	(a) lucent	(b) loosened
8	(a) tripe	(b) tribe
9	(a) burke	(b) berg
10	(a) ether	(b) either
11	(a) complacence	(b) complaisance
12	(a) grippe	(b) grebe
13	(a) clamorous	(b) glamorous
14	(a) touting	(b) doubting
15	(a) pillow	(b) billow
16	(a) charring	(b) jarring
17	(a) pumpkin	(b) bumpkin
18	(a) lope	(b) lobe
19	(a) crack	(b) crag
20	(a) alight	(b) allied
21	(a) sighting	(b) siding
22	(a) lacquered	(b) laggard
23	(a) calipers	(b) calibers
24	(a) carding	(b) guarding
25	(a) faerie	(b) vary
26	(a) delicacy	(b) delegacy
27	(a) sapping	(b) zapping
28	(a) oppressed	(b) abreast

29	(a) prick	(b) prig
30	(a) receipting	(b) receding
31	(a) maternity	(b) modernity
32	(a) disperse	(b) disburse
33	(a) loath	(b) loathe
34	(a) tensely	(b) densely
35	(a) meeker	(b) meagre
36	(a) whack	(b) wag
37	(a) trudge	(b) drudge
38	(a) referential	(b) reverential
39	(a) sleight	(b) slide
40	(a) swap	(b) swab
41	(a) thigh	(b) thy
42	(a) broke	(b) brogue
43	(a) rope	(b) robe
44	(a) abate	(b) obeyed
45	(a) thyme	(b) dime
46	(a) tessellated	(b) desolated
47	(a) crypt	(b) gripped
48	(a) painful	(b) baneful
49	(a) beseech	(b) besiege
50	(a) knacker	(b) nagger
51	(a) preach	(b) breach
52	(a) plaintiff	(b) plaintive
53	(a) apace	(b) abase
54	(a) leaking	(b) leaguing
55	(a) heartened	(b) hardened
56	(a) palate	(b) ballot
57	(a) apportion	(b) abortion
58	(a) mettlesome	(b) meddlesome
59	(a) locking	(b) logging
60	(a) adduce	(b) adieus

C Word identification task – Version 2

The following pairs of words form minimal pairs that differ in only one sound. Listen and circle the word (a) or (b) that you hear being pronounced.

1	(a) pacing	(b) basing
2	(a) towering	(b) dowering
3	(a) crammer	(b) grammar
4	(a) etching	(b) edging
5	(a) squat	(b) squad
6	(a) coast	(b) ghost
7	(a) lucent	(b) loosened
8	(a) tripe	(b) tribe
9	(a) burke	(b) berg
10	(a) ether	(b) either
11	(a) complacence	(b) complaisance
12	(a) grippe	(b) grebe
13	(a) clamorous	(b) glamorous
14	(a) touting	(b) doubting
15	(a) pillow	(b) billow
16	(a) charring	(b) jarring
17	(a) pumpkin	(b) bumpkin
18	(a) lope	(b) lobe
19	(a) crack	(b) crag
20	(a) alight	(b) allied
21	(a) sighting	(b) siding
22	(a) lacquered	(b) laggard
23	(a) calipers	(b) calibers
24	(a) carding	(b) guarding
25	(a) faerie	(b) vary
26	(a) delicacy	(b) delegacy
27	(a) sapping	(b) zapping
28	(a) oppressed	(b) abreast

29	(a) prick	(b) prig
30	(a) receipting	(b) receding
31	(a) maternity	(b) modernity
32	(a) disperse	(b) disburse
33	(a) loath	(b) loathe
34	(a) tensely	(b) densely
35	(a) meeker	(b) meagre
36	(a) whack	(b) wag
37	(a) trudge	(b) drudge
38	(a) referential	(b) reverential
39	(a) sleight	(b) slide
40	(a) swap	(b) swab
41	(a) thigh	(b) thy
42	(a) broke	(b) brogue
43	(a) rope	(b) robe
44	(a) abate	(b) obeyed
45	(a) thyme	(b) dime
46	(a) tessellated	(b) desolated
47	(a) crypt	(b) gripped
48	(a) painful	(b) baneful
49	(a) beseech	(b) besiege
50	(a) knacker	(b) nagger
51	(a) preach	(b) breach
52	(a) plaintiff	(b) plaintive
53	(a) apace	(b) abase
54	(a) leaking	(b) leaguing
55	(a) heartened	(b) hardened
56	(a) palate	(b) ballot
57	(a) apportion	(b) abortion
58	(a) mettlesome	(b) meddlesome
59	(a) locking	(b) logging
60	(a) adduce	(b) adieus

D Words-in-sentences identification task

Listen and then fill in the blanks with the missing information.

1. The baseball player left his cap in the cab.
2. They assented that their best life experience was when they had ascended Mt. Everest.
3. The managing editor and anchor of a television news magazine walked off the set in anger just before the broadcast.
4. The criminal claimed responsibility for the murders of eight foreign aid workers.
5. Croup is a respiratory disorder that normally occurs in the children in the age group of one to five.
6. The video clip's aim was to incite violence inside the country.
7. If we disburse their bonuses, maybe the angry crowd will disperse.
8. Even though he was broke at that time, Rory was very proud of his Irish heritage and the fact that he spoke with a pronounced brogue.
9. It was lovely to have the bride walk down the aisle with both her parents and to see the pride in their eyes for both their daughter and new son-in-law.
10. All the extremist movements are more clamorous than glamorous.
11. Tiger attack survivors will sue the zoo for defamation.
12. Ali decided to produce a batch of that badge as a souvenir for those who had visited the hospital or were interested in it.
13. The teacher refuses to accept her fate and fade away.
14. Some members of the rebel crowd got injured in an effort to repel the attack.
15. The prisoner planned his escape carefully after realising how bland and empty life in the prison was.
16. Nowadays, less people are willing to pare down their belongings to the bare essentials.
17. There is a big ugly off width crack at the foot of the crag.
18. It would be indecent for a woman in her seventh month of pregnancy to abort her baby just to avoid postponing a trip abroad.
19. A hardy friendship is not a hearty relationship.
20. Most states require all security officers to possess a security guard card or license as it is commonly referred to.
21. Even though the guy was out on bail, he looked pale and nervous.

22. Melissa took up a hobby that engaged her for hours at a time and made her not to feel encaged in her house.
23. The boy fell of the terrace after losing balance and that was a cause of terrors in the children of the neighbourhood.
24. I can also say that there is a similarly fine line between dilution and delusion.
25. The owner wanted to give her apartment a classy and glassy look.
26. The commuters always have to bother about the pother of city traffic that they have to face every day.
27. As a territorial delegate, Steve occupied a delicate position.
28. It’s easy to find if the user flagged a content passing the contend id and the used ID.
29. If you are a debtor, you are a deader.
30. Hopefully, when the movie comes out, it will allow us ample time to amble over to the bus stop.
31. The unheated subject went unheeded at the meeting.
32. The court decree was absolute condemning the man to life sentence for first degree murder.
33. That is a totally futile feudal custom.
34. It was revealed that their interpretation of people’s negative responses to their uninformed and pious conclusions were not from an anti-Christian bias.
35. This was likely to become an indispensable part of the inventory of the infantry in the near future.
36. He was loth to admit that he used to loathe the man who stole his brand new car and wrecked it.

E Background Questionnaire

<u>Please fill and check (√) in these sections.</u>

<u>Section A: Personal information</u>

Q1. Gender: Male ______ Female ______

Q2. Age: ______

Q3. Nationality: __________________

Q3(a). Father's nationality: __________________

Q3(b). Mother's nationality: __________________

Q4. Is Cypriot Greek your first language? Yes ______ No ______

Q4(a). If no, what is your first language? __________________

Q5. What other language(s) do you speak?

____

Q6. Have you lived in an English-speaking country? Yes ______ No ______

Q6(a). If yes, for how many years? ______

<u>Section B: Educational background</u>

Q7. What is the highest level of school you have completed?

- Lyceum ______
- American Academy ______
- Undergraduate degree (College or University) ______
- Other (please specify) ____

Q8. What programme of studies are you attending?
- Business Administration ______
- Business Computing ______

Q8(a). Are you enrolled (or enrolling) as:
- Full-time student ______
- Part-time student ______

Q8(b). Year of Study: ______

<u>Setion C: English language proficiency and usage</u>

Q9. Have you attended English private lessons? Yes______ No ______

Q9(a). If yes, for how many years have you attended English private lessons in total?

______

Q9(b). From the list below, tick the certificates in English you were awarded:

(√)	Certificate	Grade
	GCE	
	IGCSE	
	IELTS	
	TOEFL	

Q10. Do you use English outside the college? Yes ______ No ______

(If yes, answer the following questions)

Q10(a). How often do you use English?

- almost never ______
- sometimes ______
- often ______
- almost always ______

Q10(b). In what contexts do you use English?

- Home ______
- Work ______
- Friends/relatives from an English-speaking country ______
- Friends whose first language is not English ______
- Other (please specify) ____

F SPSS Output of Quantitative Analysis

Word identification task

First MANOVA (voicing X place of articulation)

Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
percentage of correctness - p	58,4073	28,66269	113
percentage of correctness - b	45,6490	23,36131	113
percentage of correctness - t	53,3627	26,89046	113
percentage of correctness - d	53,3334	26,02997	113
percentage of correctness - k	57,2280	25,85124	113
percentage of correctness - g	50,5684	25,26589	113

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
articulation	Sphericity Assumed	417,467	2	208,733	,639	,529	,006
	Greenhouse-Geisser	417,467	1,953	213,808	,639	,525	,006
	Huynh-Feldt	417,467	1,987	210,126	,639	,528	,006
	Lower-bound	417,467	1,000	417,467	,639	,426	,006
Error(articulation)	Sphericity Assumed	73125,211	224	326,452			
	Greenhouse-Geisser	73125,211	218,684	334,388			
	Huynh-Feldt	73125,211	222,515	328,630			
	Lower-bound	73125,211	112,000	652,904			
voicing	Sphericity Assumed	7122,687	1	7122,687	16,503	,000	,128
	Greenhouse-Geisser	7122,687	1,000	7122,687	16,503	,000	,128
	Huynh-Feldt	7122,687	1,000	7122,687	16,503	,000	,128
	Lower-bound	7122,687	1,000	7122,687	16,503	,000	,128
Error(voicing)	Sphericity Assumed	48339,082	112	431,599			
	Greenhouse-Geisser	48339,082	112,000	431,599			
	Huynh-Feldt	48339,082	112,000	431,599			
	Lower-bound	48339,082	112,000	431,599			
articulation * voicing	Sphericity Assumed	4579,890	2	2289,945	7,282	,001	,061
	Greenhouse-Geisser	4579,890	1,960	2336,708	7,282	,001	,061
	Huynh-Feldt	4579,890	1,995	2296,235	7,282	,001	,061
	Lower-bound	4579,890	1,000	4579,890	7,282	,008	,061

Error(articulation*voicing)	Sphericity Assumed	70439,034	224	314,460			
	Greenhouse-Geisser	70439,034	219,517	320,882			
	Huynh-Feldt	70439,034	223,386	315,324			
	Lower-bound	70439,034	112,000	628,920			

<u>Estimated Marginal Means</u>

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	56,333	2,151	52,070	60,595
2	49,850	1,900	46,086	53,615

Place of articulation X voicing

Estimates

Measure:MEASURE_1

articulation	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	58,407	2,696	53,065	63,750
	2	45,649	2,198	41,295	50,003
2	1	53,363	2,530	48,351	58,375
	2	53,333	2,449	48,482	58,185
3	1	57,228	2,432	52,410	62,046
	2	50,568	2,377	45,859	55,278

Second MANOVA (voicing X place of articulation X word position)

<u>Descriptive Statistics</u>

Descriptive Statistics

	Mean	Std. Deviation	N
winit p percentage of correctness	59.8230	42.46810	113
winit b percentage of correctness	52.7434	41.06284	113
winit t percentage of correctness	58.6283	37.90995	113
winit d percentage of correctness	56.8584	40.12366	113
winit k percentage of correctness	60.4719	38.84489	113
winit g percentage of correctness	60.3247	40.78361	113
wmed p percentage of correctness	62.3894	40.52169	113
wmed b percentage of correctness	56.1947	39.46220	113
wmed t percentage of correctness	51.0325	35.79382	113
wmed d percentage of correctness	56.9324	35.12541	113
wmed k percentage of correctness	52.7434	42.17836	113
wmed g percentage of correctness	52.0354	40.22613	113
wfin p percentage of correctness	54.7198	35.17790	113
wfin b percentage of correctness	34.8079	33.44945	113
wfin t percentage of correctness	54.6460	37.58156	113
wfin d percentage of correctness	38.4956	38.53271	113
wfin k percentage of correctness	58.4068	34.07903	113

Descriptive Statistics

	Mean	Std. Deviation	N
winit p percentage of correctness	59.8230	42.46810	113
winit b percentage of correctness	52.7434	41.06284	113
winit t percentage of correctness	58.6283	37.90995	113
winit d percentage of correctness	56.8584	40.12366	113
winit k percentage of correctness	60.4719	38.84489	113
winit g percentage of correctness	60.3247	40.78361	113
wmed p percentage of correctness	62.3894	40.52169	113
wmed b percentage of correctness	56.1947	39.46220	113
wmed t percentage of correctness	51.0325	35.79382	113
wmed d percentage of correctness	56.9324	35.12541	113
wmed k percentage of correctness	52.7434	42.17836	113
wmed g percentage of correctness	52.0354	40.22613	113
wfin p percentage of correctness	54.7198	35.17790	113
wfin b percentage of correctness	34.8079	33.44945	113
wfin t percentage of correctness	54.6460	37.58156	113
wfin d percentage of correctness	38.4956	38.53271	113
wfin k percentage of correctness	58.4068	34.07903	113
wfin g percentage of correctness	36.5782	34.42169	113

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Sphericity Assumed	51833.328	2	25916.664	13.537	.000	.108
	Greenhouse-Geisser	51833.328	1.808	28673.932	13.537	.000	.108
	Huynh-Feldt	51833.328	1.836	28237.958	13.537	.000	.108
	Lower-bound	51833.328	1.000	51833.328	13.537	.000	.108
Error(wordp)	Sphericity Assumed	428833.932	224	1914.437			
	Greenhouse-Geisser	428833.932	202.460	2118.114			
	Huynh-Feldt	428833.932	205.586	2085.909			
	Lower-bound	428833.932	112.000	3828.874			
articulation	Sphericity Assumed	203.650	2	101.825	.096	.909	.001
	Greenhouse-Geisser	203.650	1.941	104.928	.096	.904	.001
	Huynh-Feldt	203.650	1.975	103.138	.096	.907	.001
	Lower-bound	203.650	1.000	203.650	.096	.758	.001
Error(articulation)	Sphericity Assumed	238605.042	224	1065.201			
	Greenhouse-Geisser	238605.042	217.376	1097.659			
	Huynh-Feldt	238605.042	221.149	1078.931			
	Lower-bound	238605.042	112.000	2130.402			
voicing	Sphericity Assumed	28935.057	1	28935.057	21.598	.000	.162
	Greenhouse-Geisser	28935.057	1.000	28935.057	21.598	.000	.162
	Huynh-Feldt	28935.057	1.000	28935.057	21.598	.000	.162

	Lower-bound	28935.057	1.000	28935.057	21.598	.000	.162
Error(voicing)	Sphericity Assumed	150049.158	112	1339.725			
	Greenhouse-Geisser	150049.158	112.000	1339.725			
	Huynh-Feldt	150049.158	112.000	1339.725			
	Lower-bound	150049.158	112.000	1339.725			
wordp * articulation	Sphericity Assumed	8538.922	4	2134.731	2.049	.087	.018
	Greenhouse-Geisser	8538.922	3.682	2318.788	2.049	.093	.018
	Huynh-Feldt	8538.922	3.823	2233.437	2.049	.090	.018
	Lower-bound	8538.922	1.000	8538.922	2.049	.155	.018
Error(wordp*articulation)	Sphericity Assumed	466855.180	448	1042.087			
	Greenhouse-Geisser	466855.180	412.439	1131.937			
	Huynh-Feldt	466855.180	428.201	1090.272			
	Lower-bound	466855.180	112.000	4168.350			
wordp * voicing	Sphericity Assumed	35725.670	2	17862.835	18.464	.000	.142
	Greenhouse-Geisser	35725.670	1.963	18203.572	18.464	.000	.142
	Huynh-Feldt	35725.670	1.997	17887.639	18.464	.000	.142
	Lower-bound	35725.670	1.000	35725.670	18.464	.000	.142
Error(wordp*voicing)	Sphericity Assumed	216709.711	224	967.454			
	Greenhouse-Geisser	216709.711	219.807	985.908			
	Huynh-Feldt	216709.711	223.689	968.797			
	Lower-bound	216709.711	112.000	1934.908			
articulation * voicing	Sphericity Assumed	4218.680	2	2109.340	1.917	.149	.017
	Greenhouse-Geisser	4218.680	1.931	2184.978	1.917	.151	.017

	Huynh-Feldt	4218.680	1.964	2147.998	1.917	.150	.017
	Lower-bound	4218.680	1.000	4218.680	1.917	.169	.017
Error(articulation*voicing)	Sphericity Assumed	246470.932	224	1100.317			
	Greenhouse-Geisser	246470.932	216.246	1139.772			
	Huynh-Feldt	246470.932	219.969	1120.482			
	Lower-bound	246470.932	112.000	2200.633			
wordp * articulation * voicing	Sphericity Assumed	2354.070	4	588.518	.619	.649	.005
	Greenhouse-Geisser	2354.070	3.802	619.199	.619	.641	.005
	Huynh-Feldt	2354.070	3.952	595.660	.619	.647	.005
	Lower-bound	2354.070	1.000	2354.070	.619	.433	.005
Error(wordp*articulation*voicing)	Sphericity Assumed	426046.111	448	950.996			
	Greenhouse-Geisser	426046.111	425.802	1000.574			
	Huynh-Feldt	426046.111	442.628	962.537			
	Lower-bound	426046.111	112.000	3803.983			

Estimated Marginal Means

Word position

Estimates

Measure:MEASURE_1

wordp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	58.142	2.885	52.426	63.857
2	55.221	2.354	50.558	59.885
3	46.276	1.460	43.384	49.168

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	56.985	2.104	52.815	61.154
2	49.441	1.946	45.586	53.296

Word position X voicing

Estimates

Measure:MEASURE_1

wordp	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	59.641	3.011	53.675	65.607
	2	56.642	3.143	50.414	62.870
2	1	55.388	2.793	49.854	60.923
	2	55.054	2.547	50.007	60.101
3	1	55.924	2.086	51.791	60.058
	2	36.627	2.013	32.640	40.615

Tests of Within-Subjects Contrasts

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
wordp	Level 1 vs. Level 3	15910,352	1	15910,352	19,313	,000	,147	19,313	,992
	Level 2 vs. Level 3	9042,605	1	9042,605	14,427	,000	,114	14,427	,965
Error(wordp)	Level 1 vs. Level 3	92267,140	112	823,814					
	Level 2 vs. Level 3	70200,932	112	626,794					
articulation	Level 1 vs. Level 3	,043	1	,043	,000	,992	,000	,000	,050
	Level 2 vs. Level 3	49,403	1	49,403	,146	,703	,001	,146	,067

Error(articulation)		Level 1 vs. Level 3	46508,276	112	415,252					
		Level 2 vs. Level 3	37833,475	112	337,799					
voicing		Level 1 vs. Level 2	6430,013	1	6430,013	21,598	,000	,162	21,598	,996
Error(voicing)		Level 1 vs. Level 2	33344,257	112	297,717					
wordp * articulation	Level 1 vs. Level 3	Level 1 vs. Level 3	217,217	1	217,217	,081	,777	,001	,081	,059
		Level 2 vs. Level 3	339,462	1	339,462	,199	,657	,002	,199	,073
	Level 2 vs. Level 3	Level 1 vs. Level 3	10482,159	1	10482,159	5,701	,019	,048	5,701	,658
		Level 2 vs. Level 3	714,625	1	714,625	,348	,556	,003	,348	,090

Error(wordp*articulation)	Level 1 vs. Level 3	Level 1 vs. Level 3	301268,167	112	2689,894					
		Level 2 vs. Level 3	191207,358	112	1707,209					
	Level 2 vs. Level 3	Level 1 vs. Level 3	205916,255	112	1838,538					
		Level 2 vs. Level 3	230055,129	112	2054,064					
wordp * voicing	Level 1 vs. Level 3	Level 1 vs. Level 2	30015,798	1	30015,798	21,796	,000	,163	21,796	,996
	Level 2 vs. Level 3	Level 1 vs. Level 2	40633,177	1	40633,177	29,425	,000	,208	29,425	1,000
Error(wordp*voicing)	Level 1 vs. Level 3	Level 1 vs. Level 2	154234,428	112	1377,093					
	Level 2 vs. Level 3	Level 1 vs. Level 2	154663,914	112	1380,928					

articulation * voicing		Level 1 vs. Level 3	Level 1 vs. Level 2	1384,903	1	1384,903	1,045	,309	,009	1,045	,173
		Level 2 vs. Level 3	Level 1 vs. Level 2	1427,658	1	1427,658	1,073	,303	,009	1,073	,177
Error(articulation*voicing)		Level 1 vs. Level 3	Level 1 vs. Level 2	148485,165	112	1325,760					
		Level 2 vs. Level 3	Level 1 vs. Level 2	149029,353	112	1330,619					
wordp * articulation * voicing	Level 1 vs. Level 3	Level 1 vs. Level 3	Level 1 vs. Level 2	8848,496	1	8848,496	1,382	,242	,012	1,382	,214
		Level 2 vs. Level 3	Level 1 vs. Level 2	6023,084	1	6023,084	,838	,362	,007	,838	,148
	Level 2 vs. Level 3	Level 1 vs. Level 3	Level 1 vs. Level 2	6193,505	1	6193,505	,727	,396	,006	,727	,135
		Level 2 vs. Level 3	Level 1 vs. Level 2	97,678	1	97,678	,011	,915	,000	,011	,051

Error(wordp*articulation*voicing)	Level 1 vs. Level 3	Level 1 vs. Level 3	Level 1 vs. Level 2	716882,729	112	6400,739					
		Level 2 vs. Level 3	Level 1 vs. Level 2	805176,195	112	7189,073					
	Level 2 vs. Level 3	Level 1 vs. Level 3	Level 1 vs. Level 2	954399,752	112	8521,426					
		Level 2 vs. Level 3	Level 1 vs. Level 2	959206,046	112	8564,340					

a. Computed using alpha = ,05

Third MANOVA (voicing X place of articulation X syllable position)

<u>Descriptive Statistics</u>

Descriptive Statistics

	Mean	Std. Deviation	N
percentage of correctness: p	60,2259	33,54469	113
percentage of correctness: b	53,8347	32,86852	113
percentage of correctness: t	53,5108	32,10766	113
percentage of correctness: d	57,1973	30,90413	113
percentage of correctness: k	59,4179	31,58878	113
percentage of correctness: g	55,2148	31,81834	113
percentage of correctness: p	54,8673	35,47365	113
percentage of correctness: b	35,1029	33,58307	113
percentage of correctness: t	40,4867	25,73009	113
percentage of correctness: d	38,7168	38,38119	113
percentage of correctness: k	58,1118	32,28457	113
percentage of correctness: g	37,6107	34,84568	113

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
syllable	Sphericity Assumed	52272,056	1	52272,056	30,120	,000	,212	30,120	1,000
	Greenhouse-Geisser	52272,056	1,000	52272,056	30,120	,000	,212	30,120	1,000
	Huynh-Feldt	52272,056	1,000	52272,056	30,120	,000	,212	30,120	1,000
	Lower-bound	52272,056	1,000	52272,056	30,120	,000	,212	30,120	1,000
Error(syllable)	Sphericity Assumed	194373,927	112	1735,481					
	Greenhouse-Geisser	194373,927	112,000	1735,481					
	Huynh-Feldt	194373,927	112,000	1735,481					
	Lower-bound	194373,927	112,000	1735,481					
articulation	Sphericity Assumed	6189,457	2	3094,728	3,659	,027	,032	7,317	,670
	Greenhouse-Geisser	6189,457	1,949	3175,362	3,659	,028	,032	7,132	,662
	Huynh-Feldt	6189,457	1,983	3120,825	3,659	,028	,032	7,256	,667
	Lower-bound	6189,457	1,000	6189,457	3,659	,058	,032	3,659	,475
Error(articulation)	Sphericity Assumed	189473,185	224	845,862					
	Greenhouse-Geisser	189473,185	218,312	867,901					
	Huynh-Feldt	189473,185	222,127	852,995					

	Lower-bound	189473,185	112,000	1691,725					
voicing	Sphericity Assumed	22557,017	1	22557,017	20,764	,000	,156	20,764	,995
	Greenhouse-Geisser	22557,017	1,000	22557,017	20,764	,000	,156	20,764	,995
	Huynh-Feldt	22557,017	1,000	22557,017	20,764	,000	,156	20,764	,995
	Lower-bound	22557,017	1,000	22557,017	20,764	,000	,156	20,764	,995
Error(voicing)	Sphericity Assumed	121670,281	112	1086,342					
	Greenhouse-Geisser	121670,281	112,000	1086,342					
	Huynh-Feldt	121670,281	112,000	1086,342					
	Lower-bound	121670,281	112,000	1086,342					
syllable * articulation	Sphericity Assumed	2263,964	2	1131,982	1,699	,185	,015	3,398	,355
	Greenhouse-Geisser	2263,964	1,970	1149,174	1,699	,186	,015	3,347	,352
	Huynh-Feldt	2263,964	2,000	1131,982	1,699	,185	,015	3,398	,355
	Lower-bound	2263,964	1,000	2263,964	1,699	,195	,015	1,699	,253
Error(syllable*articulation)	Sphericity Assumed	149238,063	224	666,241					
	Greenhouse-Geisser	149238,063	220,649	676,360					
	Huynh-Feldt	149238,063	224,000	666,241					
	Lower-bound	149238,063	112,000	1332,483					
syllable * voicing	Sphericity Assumed	11619,570	1	11619,570	17,328	,000	,134	17,328	,985
	Greenhouse-Geisser	11619,570	1,000	11619,570	17,328	,000	,134	17,328	,985

	Huynh-Feldt	11619,570	1,000	11619,570	17,328	,000	,134	17,328	,985
	Lower-bound	11619,570	1,000	11619,570	17,328	,000	,134	17,328	,985
Error(syllable*voicing)	Sphericity Assumed	75104,184	112	670,573					
	Greenhouse-Geisser	75104,184	112,000	670,573					
	Huynh-Feldt	75104,184	112,000	670,573					
	Lower-bound	75104,184	112,000	670,573					
articulation * voicing	Sphericity Assumed	14113,821	2	7056,910	9,715	,000	,080	19,430	,981
	Greenhouse-Geisser	14113,821	1,936	7291,135	9,715	,000	,080	18,806	,979
	Huynh-Feldt	14113,821	1,969	7167,242	9,715	,000	,080	19,131	,980
	Lower-bound	14113,821	1,000	14113,821	9,715	,002	,080	9,715	,871
Error(articulation*voicing)	Sphericity Assumed	162707,947	224	726,375					
	Greenhouse-Geisser	162707,947	216,804	750,484					
	Huynh-Feldt	162707,947	220,552	737,731					
	Lower-bound	162707,947	112,000	1452,750					
syllable * articulation * voicing	Sphericity Assumed	1777,580	2	888,790	1,171	,312	,010	2,343	,255
	Greenhouse-Geisser	1777,580	1,965	904,823	1,171	,311	,010	2,301	,253
	Huynh-Feldt	1777,580	1,999	889,095	1,171	,312	,010	2,342	,255
	Lower-bound	1777,580	1,000	1777,580	1,171	,281	,010	1,171	,189
Error(syllable*articulation*voicing)	Sphericity Assumed	169973,564	224	758,811					

	Greenhouse-Geisser	169973,564	220,031	772,499					
	Huynh-Feldt	169973,564	223,923	759,071					
	Lower-bound	169973,564	112,000	1517,621					

a. Computed using alpha = ,05

Estimated Marginal Means

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	54,437	1,903	50,666	58,207
2	46,280	1,770	42,773	49,786

Place of articulation

Estimates

Measure:MEASURE_1

articulation	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	51,008	1,950	47,144	54,871
2	47,478	1,890	43,733	51,223
3	52,589	2,024	48,579	56,598

Syllable position

Estimates

Measure:MEASURE_1

syllable	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	56,567	2,460	51,693	61,441
2	44,149	1,289	41,596	46,702

Syllable position X voicing

Estimates

Measure:MEASURE_1

syllable	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	57,718	2,650	52,468	62,968
	2	55,416	2,555	50,352	60,479
2	1	51,155	1,719	47,749	54,562
	2	37,143	2,024	33,132	41,155

Place of articulation X voicing

Estimates

Measure:MEASURE_1

articulation	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	57,547	2,650	52,296	62,797
	2	44,469	2,198	40,115	48,823
2	1	46,999	2,185	42,670	51,328
	2	47,957	2,488	43,028	52,886
3	1	58,765	2,375	54,059	63,470
	2	46,413	2,392	41,674	51,152

Words-in-sentences identification task

First MANOVA (voicing X place of articulation)

Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
percentage of correctness - p	51.6667	20.69205	30
percentage of correctness - b	37.3333	21.64499	30
percentage of correctness - t	39.3333	21.16167	30
percentage of correctness - d	29.0000	17.48891	30
percentage of correctness - k	51.0000	21.22945	30
percentage of correctness - g	43.6667	24.70283	30

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
articulation	Sphericity Assumed	5763.333	2	2881.667	14.322	.000	.331
	Greenhouse-Geisser	5763.333	1.869	3083.104	14.322	.000	.331
	Huynh-Feldt	5763.333	1.993	2891.338	14.322	.000	.331
	Lower-bound	5763.333	1.000	5763.333	14.322	.001	.331
Error(articulation)	Sphericity Assumed	11670.000	58	201.207			
	Greenhouse-Geisser	11670.000	54.211	215.272			
	Huynh-Feldt	11670.000	57.806	201.882			
	Lower-bound	11670.000	29.000	402.414			
voicing	Sphericity Assumed	5120.000	1	5120.000	20.119	.000	.410
	Greenhouse-Geisser	5120.000	1.000	5120.000	20.119	.000	.410
	Huynh-Feldt	5120.000	1.000	5120.000	20.119	.000	.410
	Lower-bound	5120.000	1.000	5120.000	20.119	.000	.410
Error(voicing)	Sphericity Assumed	7380.000	29	254.483			
	Greenhouse-Geisser	7380.000	29.000	254.483			
	Huynh-Feldt	7380.000	29.000	254.483			
	Lower-bound	7380.000	29.000	254.483			
articulation * voicing	Sphericity Assumed	370.000	2	185.000	1.258	.292	.042
	Greenhouse-Geisser	370.000	1.882	196.549	1.258	.291	.042
	Huynh-Feldt	370.000	2.000	185.000	1.258	.292	.042
	Lower-bound	370.000	1.000	370.000	1.258	.271	.042

Error(articulation*voicing)	Sphericity Assumed	8530.000	58	147.069			
	Greenhouse-Geisser	8530.000	54.592	156.250			
	Huynh-Feldt	8530.000	58.000	147.069			
	Lower-bound	8530.000	29.000	294.138			

Estimated Marginal Means

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	47.333	3.154	40.883	53.784
2	36.667	3.527	29.453	43.880

Place of articulation

Estimates

Measure:MEASURE_1

articulation	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	44.500	3.567	37.205	51.795
2	34.167	3.136	27.754	40.580
3	47.333	3.673	39.821	54.845

Second MANOVA (voicing X place of articulation X word position)

Word medial vs. word-final category

<u>Descriptive Statistics</u>

Descriptive Statistics

	Mean	Std. Deviation	N
wmed p percentage of correctness	27.7767	23.29828	30
wmed b percentage of correctness	12.2213	18.53427	30
wmed t percentage of correctness	34.6667	23.44963	30
wmed d percentage of correctness	24.0000	19.93092	30
wmed k percentage of correctness	36.6667	26.04152	30
wmed g percentage of correctness	44.1667	29.85838	30
wfin p percentage of correctness	80.0000	40.68381	30
wfin b percentage of correctness	33.3333	47.94633	30
wfin t percentage of correctness	44.0000	24.85822	30
wfin d percentage of correctness	34.0000	22.98425	30
wfin k percentage of correctness	66.6667	33.04473	30
wfin g percentage of correctness	16.6667	30.32392	30

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Sphericity Assumed	22642.688	1	22642.688	25.366	.000	.467
	Greenhouse-Geisser	22642.688	1.000	22642.688	25.366	.000	.467
	Huynh-Feldt	22642.688	1.000	22642.688	25.366	.000	.467
	Lower-bound	22642.688	1.000	22642.688	25.366	.000	.467
Error(wordp)	Sphericity Assumed	25886.876	29	892.651			
	Greenhouse-Geisser	25886.876	29.000	892.651			
	Huynh-Feldt	25886.876	29.000	892.651			
	Lower-bound	25886.876	29.000	892.651			
articulation	Sphericity Assumed	2878.414	2	1439.207	3.108	.052	.097
	Greenhouse-Geisser	2878.414	1.768	1627.685	3.108	.059	.097
	Huynh-Feldt	2878.414	1.875	1535.363	3.108	.056	.097
	Lower-bound	2878.414	1.000	2878.414	3.108	.088	.097
Error(articulation)	Sphericity Assumed	26856.239	58	463.039			
	Greenhouse-Geisser	26856.239	51.284	523.678			
	Huynh-Feldt	26856.239	54.368	493.975			
	Lower-bound	26856.239	29.000	926.077			
voicing	Sphericity Assumed	39305.794	1	39305.794	46.179	.000	.614
	Greenhouse-Geisser	39305.794	1.000	39305.794	46.179	.000	.614
	Huynh-Feldt	39305.794	1.000	39305.794	46.179	.000	.614

	Lower-bound	39305.794	1.000	39305.794	46.179	.000	.614
Error(voicing)	Sphericity Assumed	24683.703	29	851.162			
	Greenhouse-Geisser	24683.703	29.000	851.162			
	Huynh-Feldt	24683.703	29.000	851.162			
	Lower-bound	24683.703	29.000	851.162			
wordp * articulation	Sphericity Assumed	20543.054	2	10271.527	21.393	.000	.425
	Greenhouse-Geisser	20543.054	1.623	12655.129	21.393	.000	.425
	Huynh-Feldt	20543.054	1.706	12043.117	21.393	.000	.425
	Lower-bound	20543.054	1.000	20543.054	21.393	.000	.425
Error(wordp*articulation)	Sphericity Assumed	27848.299	58	480.143			
	Greenhouse-Geisser	27848.299	47.076	591.565			
	Huynh-Feldt	27848.299	49.468	562.956			
	Lower-bound	27848.299	29.000	960.286			
wordp * voicing	Sphericity Assumed	19335.661	1	19335.661	37.862	.000	.566
	Greenhouse-Geisser	19335.661	1.000	19335.661	37.862	.000	.566
	Huynh-Feldt	19335.661	1.000	19335.661	37.862	.000	.566
	Lower-bound	19335.661	1.000	19335.661	37.862	.000	.566
Error(wordp*voicing)	Sphericity Assumed	14809.803	29	510.683			
	Greenhouse-Geisser	14809.803	29.000	510.683			
	Huynh-Feldt	14809.803	29.000	510.683			
	Lower-bound	14809.803	29.000	510.683			
articulation * voicing	Sphericity Assumed	6481.244	2	3240.622	4.719	.013	.140
	Greenhouse-Geisser	6481.244	1.829	3544.412	4.719	.015	.140

	Huynh-Feldt	6481.244	1.945	3331.691	4.719	.013	.140
	Lower-bound	6481.244	1.000	6481.244	4.719	.038	.140
Error(articulation*voicing)	Sphericity Assumed	39831.176	58	686.744			
	Greenhouse-Geisser	39831.176	53.029	751.123			
	Huynh-Feldt	39831.176	56.415	706.044			
	Lower-bound	39831.176	29.000	1373.489			
wordp * articulation * voicing	Sphericity Assumed	12723.910	2	6361.955	8.311	.001	.223
	Greenhouse-Geisser	12723.910	1.733	7343.592	8.311	.001	.223
	Huynh-Feldt	12723.910	1.833	6941.771	8.311	.001	.223
	Lower-bound	12723.910	1.000	12723.910	8.311	.007	.223
Error(wordp*articulation*voicing)	Sphericity Assumed	44399.543	58	765.509			
	Greenhouse-Geisser	44399.543	50.247	883.626			
	Huynh-Feldt	44399.543	53.156	835.276			
	Lower-bound	44399.543	29.000	1531.019			

Estimated Marginal Means

Word position

Estimates

Measure:MEASURE_1

wordp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	29.916	3.119	23.537	36.295
2	45.778	3.809	37.988	53.568

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	48.296	3.234	41.683	54.910
2	27.398	3.681	19.870	34.926

Place of articulation

Estimates

Measure:MEASURE_1

articulation	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	38.333	3.542	31.088	45.578
2	34.167	3.136	27.754	40.580
3	41.042	3.775	33.321	48.762

Word position X voicing

Estimates

Measure:MEASURE_1

wordp	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	33.037	3.499	25.880	40.193
	2	26.796	3.581	19.472	34.120
2	1	63.556	4.018	55.339	71.773
	2	28.000	4.732	18.322	37.678

Place of articulation X voicing

Estimates

Measure:MEASURE_1

articulation	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	53.888	4.706	44.263	63.513
	2	22.777	4.760	13.042	32.513
2	1	39.333	3.743	31.679	46.988
	2	29.000	3.229	22.396	35.604
3	1	51.667	4.141	43.198	60.135
	2	30.417	4.894	20.407	40.426

Word position X place of articulation X voicing

Estimates

Measure:MEASURE_1

wordp	articulation	voicing	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
1	1	1	27.777	4.254	19.077	36.476
		2	12.221	3.384	5.301	19.142
	2	1	34.667	4.281	25.910	43.423
		2	24.000	3.639	16.558	31.442
	3	1	36.667	4.755	26.943	46.391
		2	44.167	5.451	33.017	55.316
2	1	1	80.000	7.428	64.808	95.192
		2	33.333	8.754	15.430	51.237
	2	1	44.000	4.538	34.718	53.282
		2	34.000	4.196	25.418	42.582
	3	1	66.667	6.033	54.328	79.006
		2	16.667	5.536	5.344	27.990

Tests of Within-Subjects Contrasts 1

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Level 1 vs. Level 2		7547,563	1	7547,563	25,366	,000	,467
Error(wordp)	Level 1 vs. Level 2		8628,959	29	297,550			
articulation	Level 1 vs. Level 3		220,133	1	220,133	,721	,403	,024
	Level 2 vs. Level 3		1417,969	1	1417,969	8,845	,006	,234
Error(articulation)	Level 1 vs. Level 3		8855,502	29	305,362			
	Level 2 vs. Level 3		4649,219	29	160,318			
voicing		Level 1 vs. Level 2	13101,931	1	13101,931	46,179	,000	,614
Error(voicing)		Level 1 vs. Level 2	8227,901	29	283,721			
wordp * articulation	Level 1 vs. Level 2	Level 1 vs. Level 3	37632,333	1	37632,333	26,507	,000	,478
		Level 2 vs. Level 3	2125,208	1	2125,208	2,734	,109	,086
Error(wordp*articulation)	Level 1 vs. Level 2	Level 1 vs. Level 3	41171,708	29	1419,714			

		Level 2 vs. Level 3		22543,542	29	777,364			
wordp * voicing	Level 1 vs. Level 2		Level 1 vs. Level 2	25780,881	1	25780,881	37,862	,000	,566
Error(wordp*voicing)	Level 1 vs. Level 2		Level 1 vs. Level 2	19746,404	29	680,910			
articulation * voicing		Level 1 vs. Level 3	Level 1 vs. Level 2	2917,180	1	2917,180	1,827	,187	,059
		Level 2 vs. Level 3	Level 1 vs. Level 2	3575,208	1	3575,208	3,751	,063	,115
Error(articulation*voicing)		Level 1 vs. Level 3	Level 1 vs. Level 2	46301,862	29	1596,616			
		Level 2 vs. Level 3	Level 1 vs. Level 2	27643,542	29	953,226			
wordp * articulation * voicing	Level 1 vs. Level 2	Level 1 vs. Level 3	Level 1 vs. Level 2	20890,852	1	20890,852	2,532	,122	,080
		Level 2 vs. Level 3	Level 1 vs. Level 2	101500,833	1	101500,833	24,824	,000	,461
Error(wordp*articulation*voicing)	Level 1 vs. Level 2	Level 1 vs. Level 3	Level 1 vs. Level 2	239315,315	29	8252,252			
		Level 2 vs. Level 3	Level 1 vs. Level 2	118574,167	29	4088,764			

Tests of Within-Subjects Contrasts 2

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source				Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Level 2 vs. Level 1			7547,563	1	7547,563	25,366	,000	,467
Error(wordp)	Level 2 vs. Level 1			8628,959	29	297,550			
articulation		Level 2 vs. Level 1		520,708	1	520,708	2,275	,142	,073
		Level 3 vs. Level 1		220,133	1	220,133	,721	,403	,024
Error(articulation)		Level 2 vs. Level 1		6637,458	29	228,878			
		Level 3 vs. Level 1		8855,502	29	305,362			
voicing			Level 2 vs. Level 1	13101,931	1	13101,931	46,179	,000	,614
Error(voicing)			Level 2 vs. Level 1	8227,901	29	283,721			
wordp * articulation	Level 2 vs. Level 1	Level 2 vs. Level 1		21871,620	1	21871,620	31,986	,000	,524
		Level 3 vs. Level 1		37632,333	1	37632,333	26,507	,000	,478
Error(wordp*articulation)	Level 2 vs. Level 1	Level 2 vs. Level 1		19829,647	29	683,781			

		Level 3 vs. Level 1		41171,708	29	1419,714			
wordp * voicing	Level 2 vs. Level 1		Level 2 vs. Level 1	25780,881	1	25780,881	37,862	,000	,566
Error(wordp*voicing)	Level 2 vs. Level 1		Level 2 vs. Level 1	19746,404	29	680,910			
articulation * voicing		Level 2 vs. Level 1	Level 2 vs. Level 1	12951,343	1	12951,343	8,246	,008	,221
		Level 3 vs. Level 1	Level 2 vs. Level 1	2917,180	1	2917,180	1,827	,187	,059
Error(articulation*voicing)		Level 2 vs. Level 1	Level 2 vs. Level 1	45548,124	29	1570,625			
		Level 3 vs. Level 1	Level 2 vs. Level 1	46301,862	29	1596,616			
wordp * articulation * voicing	Level 2 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	30295,239	1	30295,239	5,023	,033	,148
		Level 3 vs. Level 1	Level 2 vs. Level 1	20890,852	1	20890,852	2,532	,122	,080
Error(wordp*articulation*voicing)	Level 2 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	174905,028	29	6031,208			
		Level 3 vs. Level 1	Level 2 vs. Level 1	239315,315	29	8252,252			

Bilabial vs. velar plosives

Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
winit p percentage of correctness	59,4443	24,24415	30
winit b percentage of correctness	50,0000	29,68442	30
winit k percentage of correctness	58,3333	28,86751	30
winit g percentage of correctness	56,6667	30,03829	30
wmed p percentage of correctness	27,7767	23,29828	30
wmed b percentage of correctness	12,2213	18,53427	30
wmed k percentage of correctness	36,6667	26,04152	30
wmed g percentage of correctness	44,1667	29,85838	30
wfin p percentage of correctness	80,0000	40,68381	30
wfin b percentage of correctness	33,3333	47,94633	30
wfin k percentage of correctness	66,6667	33,04473	30
wfin g percentage of correctness	16,6667	30,32392	30

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Sphericity Assumed	43145,626	2	21572,813	30,001	,000	,508
	Greenhouse-Geisser	43145,626	1,719	25101,419	30,001	,000	,508
	Huynh-Feldt	43145,626	1,817	23747,581	30,001	,000	,508
	Lower-bound	43145,626	1,000	43145,626	30,001	,000	,508
Error(wordp)	Sphericity Assumed	41706,573	58	719,079			
	Greenhouse-Geisser	41706,573	49,847	836,697			
	Huynh-Feldt	41706,573	52,688	791,570			
	Lower-bound	41706,573	29,000	1438,158			
articulation	Sphericity Assumed	671,662	1	671,662	1,565	,221	,051
	Greenhouse-Geisser	671,662	1,000	671,662	1,565	,221	,051
	Huynh-Feldt	671,662	1,000	671,662	1,565	,221	,051
	Lower-bound	671,662	1,000	671,662	1,565	,221	,051
Error(articulation)	Sphericity Assumed	12447,833	29	429,236			
	Greenhouse-Geisser	12447,833	29,000	429,236			
	Huynh-Feldt	12447,833	29,000	429,236			
	Lower-bound	12447,833	29,000	429,236			
voicing	Sphericity Assumed	33543,210	1	33543,210	32,711	,000	,530
	Greenhouse-Geisser	33543,210	1,000	33543,210	32,711	,000	,530
	Huynh-Feldt	33543,210	1,000	33543,210	32,711	,000	,530

	Lower-bound	33543,210	1,000	33543,210	32,711	,000	,530
Error(voicing)	Sphericity Assumed	29737,749	29	1025,440			
	Greenhouse-Geisser	29737,749	29,000	1025,440			
	Huynh-Feldt	29737,749	29,000	1025,440			
	Lower-bound	29737,749	29,000	1025,440			
wordp * articulation	Sphericity Assumed	18816,262	2	9408,131	13,253	,000	,314
	Greenhouse-Geisser	18816,262	1,442	13052,298	13,253	,000	,314
	Huynh-Feldt	18816,262	1,497	12571,372	13,253	,000	,314
	Lower-bound	18816,262	1,000	18816,262	13,253	,001	,314
Error(wordp*articulation)	Sphericity Assumed	41172,354	58	709,868			
	Greenhouse-Geisser	41172,354	41,807	984,830			
	Huynh-Feldt	41172,354	43,406	948,543			
	Lower-bound	41172,354	29,000	1419,736			
wordp * voicing	Sphericity Assumed	37952,694	2	18976,347	31,201	,000	,518
	Greenhouse-Geisser	37952,694	1,726	21986,203	31,201	,000	,518
	Huynh-Feldt	37952,694	1,825	20791,204	31,201	,000	,518
	Lower-bound	37952,694	1,000	37952,694	31,201	,000	,518
Error(wordp*voicing)	Sphericity Assumed	35275,931	58	608,206			
	Greenhouse-Geisser	35275,931	50,060	704,674			
	Huynh-Feldt	35275,931	52,937	666,373			
	Lower-bound	35275,931	29,000	1216,411			
articulation * voicing	Sphericity Assumed	1890,579	1	1890,579	3,036	,092	,095
	Greenhouse-Geisser	1890,579	1,000	1890,579	3,036	,092	,095

	Huynh-Feldt	1890,579	1,000	1890,579	3,036	,092	,095
	Lower-bound	1890,579	1,000	1890,579	3,036	,092	,095
Error(articulation*voicing)	Sphericity Assumed	18057,629	29	622,677			
	Greenhouse-Geisser	18057,629	29,000	622,677			
	Huynh-Feldt	18057,629	29,000	622,677			
	Lower-bound	18057,629	29,000	622,677			
wordp * articulation * voicing	Sphericity Assumed	2633,058	2	1316,529	1,755	,182	,057
	Greenhouse-Geisser	2633,058	1,561	1686,921	1,755	,190	,057
	Huynh-Feldt	2633,058	1,634	1611,762	1,755	,189	,057
	Lower-bound	2633,058	1,000	2633,058	1,755	,196	,057
Error(wordp*articulation*voicing)	Sphericity Assumed	43512,317	58	750,212			
	Greenhouse-Geisser	43512,317	45,265	961,277			
	Huynh-Feldt	43512,317	47,376	918,448			
	Lower-bound	43512,317	29,000	1500,425			

Estimated Marginal Means

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	54,815	3,437	47,785	61,844
2	35,509	3,995	27,338	43,680

Word position

Estimates

Measure:MEASURE_1

wordp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	56.111	4.088	47.750	64.472
2	30.208	3.233	23.595	36.821
3	49.167	4.235	40.505	57.828

Word position X place of articulation

Estimates

Measure:MEASURE_1

wordp	articulation	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	54.722	4.443	45.634	63.810
	2	57.500	4.742	47.802	67.198
2	1	19.999	3.032	13.797	26.201
	2	40.417	4.006	32.223	48.610
3	1	56.667	5.740	44.927	68.407
	2	41.667	4.538	32.385	50.948

Tests of Within-Subjects Contrasts 1

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source				Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Level 1 vs. Level 3			1446,748	1	1446,748	3,148	,087	,098
	Level 2 vs. Level 3			10783,121	1	10783,121	26,897	,000	,481
Error(wordp)	Level 1 vs. Level 3			13327,832	29	459,580			
	Level 2 vs. Level 3			11626,327	29	400,908			
articulation		Level 1 vs. Level 2		223,887	1	223,887	1,565	,221	,051
Error(articulation)		Level 1 vs. Level 2		4149,278	29	143,079			
voicing			Level 1 vs. Level 2	11181,070	1	11181,070	32,711	,000	,530
Error(voicing)			Level 1 vs. Level 2	9912,583	29	341,813			
wordp * articulation	Level 1 vs. Level 3	Level 1 vs. Level 2		9481,541	1	9481,541	4,339	,046	,130
	Level 2 vs. Level 3	Level 1 vs. Level 2		37632,333	1	37632,333	26,507	,000	,478
Error(wordp*articulation)	Level 1 vs. Level 3	Level 1 vs. Level 2		63364,029	29	2184,967			

	Level 2 vs. Level 3	Level 1 vs. Level 2		41171,708	29	1419,714			
wordp * voicing	Level 1 vs. Level 3		Level 1 vs. Level 2	54898,291	1	54898,291	37,372	,000	,563
	Level 2 vs. Level 3		Level 1 vs. Level 2	58889,763	1	58889,763	40,665	,000	,584
Error(wordp*voicing)	Level 1 vs. Level 3		Level 1 vs. Level 2	42600,001	29	1468,966			
	Level 2 vs. Level 3		Level 1 vs. Level 2	41996,529	29	1448,156			
articulation * voicing		Level 1 vs. Level 2	Level 1 vs. Level 2	2520,772	1	2520,772	3,036	,092	,095
Error(articulation*voicing)		Level 1 vs. Level 2	Level 1 vs. Level 2	24076,839	29	830,236			
wordp * articulation * voicing	Level 1 vs. Level 3	Level 1 vs. Level 2	Level 1 vs. Level 2	3703,630	1	3703,630	,543	,467	,018
	Level 2 vs. Level 3	Level 1 vs. Level 2	Level 1 vs. Level 2	20890,852	1	20890,852	2,532	,122	,080
Error(wordp*articulation*voicing)	Level 1 vs. Level 3	Level 1 vs. Level 2	Level 1 vs. Level 2	197960,537	29	6826,225			
	Level 2 vs. Level 3	Level 1 vs. Level 2	Level 1 vs. Level 2	239315,315	29	8252,252			

Tests of Within-Subjects Contrasts 2

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source				Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
wordp	Level 2 vs. Level 1			20129,351	1	20129,351	92,281	,000	,761
	Level 3 vs. Level 1			1446,748	1	1446,748	3,148	,087	,098
Error(wordp)	Level 2 vs. Level 1			6325,771	29	218,130			
	Level 3 vs. Level 1			13327,832	29	459,580			
articulation		Level 2 vs. Level 1		223,887	1	223,887	1,565	,221	,051
Error(articulation)		Level 2 vs. Level 1		4149,278	29	143,079			
voicing			Level 2 vs. Level 1	11181,070	1	11181,070	32,711	,000	,530
Error(voicing)			Level 2 vs. Level 1	9912,583	29	341,813			
wordp * articulation	Level 2 vs. Level 1	Level 2 vs. Level 1		9334,912	1	9334,912	14,262	,001	,330
	Level 3 vs. Level 1	Level 2 vs. Level 1		9481,541	1	9481,541	4,339	,046	,130
Error(wordp*articulation)	Level 2 vs. Level 1	Level 2 vs. Level 1		18981,325	29	654,528			

	Level 3 vs. Level 1	Level 2 vs. Level 1		63364,029	29	2184,967			
wordp * voicing	Level 2 vs. Level 1		Level 2 vs. Level 1	70,028	1	70,028	,096	,759	,003
	Level 3 vs. Level 1		Level 2 vs. Level 1	54898,291	1	54898,291	37,372	,000	,563
Error(wordp*voicing)	Level 2 vs. Level 1		Level 2 vs. Level 1	21231,264	29	732,113			
	Level 3 vs. Level 1		Level 2 vs. Level 1	42600,001	29	1468,966			
articulation * voicing		Level 2 vs. Level 1	Level 2 vs. Level 1	2520,772	1	2520,772	3,036	,092	,095
Error(articulation*voicing)		Level 2 vs. Level 1	Level 2 vs. Level 1	24076,839	29	830,236			
wordp * articulation * voicing	Level 2 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	7002,213	1	7002,213	2,393	,133	,076
	Level 3 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	3703,630	1	3703,630	,543	,467	,018
Error(wordp*articulation*voicing)	Level 2 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	84871,955	29	2926,619			
	Level 3 vs. Level 1	Level 2 vs. Level 1	Level 2 vs. Level 1	197960,537	29	6826,225			

Third MANOVA (voicing X place of articulation X syllable position)

<u>Descriptive Statistics</u>

Descriptive Statistics

	Mean	Std. Deviation	N
percentage of correctness: p	48.5193	21.14118	30
percentage of correctness: b	37.7773	23.45444	30
percentage of correctness: t	35.3333	25.01494	30
percentage of correctness: d	23.3333	20.39833	30
percentage of correctness: k	47.5000	23.98814	30
percentage of correctness: g	50.8333	25.83380	30
percentage of correctness: p	80.0000	40.68381	30
percentage of correctness: b	33.3333	47.94633	30
percentage of correctness: t	44.0000	24.85822	30
percentage of correctness: d	34.0000	22.98425	30
percentage of correctness: k	66.6667	33.04473	30
percentage of correctness: g	16.6667	30.32392	30

Tests of Within-Subjects Effects

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
syllablep	Sphericity Assumed	2460.192	1	2460.192	3.011	.093	.094
	Greenhouse-Geisser	2460.192	1.000	2460.192	3.011	.093	.094
	Huynh-Feldt	2460.192	1.000	2460.192	3.011	.093	.094
	Lower-bound	2460.192	1.000	2460.192	3.011	.093	.094
Error(syllablep)	Sphericity Assumed	23696.684	29	817.127			
	Greenhouse-Geisser	23696.684	29.000	817.127			
	Huynh-Feldt	23696.684	29.000	817.127			
	Lower-bound	23696.684	29.000	817.127			
articulation	Sphericity Assumed	15780.157	2	7890.078	17.631	.000	.378
	Greenhouse-Geisser	15780.157	1.853	8516.617	17.631	.000	.378
	Huynh-Feldt	15780.157	1.974	7994.364	17.631	.000	.378
	Lower-bound	15780.157	1.000	15780.157	17.631	.000	.378
Error(articulation)	Sphericity Assumed	25954.995	58	447.500			
	Greenhouse-Geisser	25954.995	53.733	483.035			
	Huynh-Feldt	25954.995	57.243	453.415			
	Lower-bound	25954.995	29.000	895.000			
voicing	Sphericity Assumed	39737.474	1	39737.474	53.060	.000	.647
	Greenhouse-Geisser	39737.474	1.000	39737.474	53.060	.000	.647
	Huynh-Feldt	39737.474	1.000	39737.474	53.060	.000	.647

	Lower-bound	39737.474	1.000	39737.474	53.060	.000	.647
Error(voicing)	Sphericity Assumed	21718.637	29	748.919			
	Greenhouse-Geisser	21718.637	29.000	748.919			
	Huynh-Feldt	21718.637	29.000	748.919			
	Lower-bound	21718.637	29.000	748.919			
syllablep * articulation	Sphericity Assumed	7513.001	2	3756.501	6.578	.003	.185
	Greenhouse-Geisser	7513.001	1.618	4642.663	6.578	.005	.185
	Huynh-Feldt	7513.001	1.700	4419.545	6.578	.005	.185
	Lower-bound	7513.001	1.000	7513.001	6.578	.016	.185
Error(syllablep*articulation)	Sphericity Assumed	33120.450	58	571.042			
	Greenhouse-Geisser	33120.450	46.929	705.752			
	Huynh-Feldt	33120.450	49.299	671.834			
	Lower-bound	33120.450	29.000	1142.084			
syllablep * voicing	Sphericity Assumed	19034.896	1	19034.896	46.881	.000	.618
	Greenhouse-Geisser	19034.896	1.000	19034.896	46.881	.000	.618
	Huynh-Feldt	19034.896	1.000	19034.896	46.881	.000	.618
	Lower-bound	19034.896	1.000	19034.896	46.881	.000	.618
Error(syllablep*voicing)	Sphericity Assumed	11774.648	29	406.022			
	Greenhouse-Geisser	11774.648	29.000	406.022			
	Huynh-Feldt	11774.648	29.000	406.022			
	Lower-bound	11774.648	29.000	406.022			
articulation * voicing	Sphericity Assumed	4944.022	2	2472.011	3.710	.030	.113
	Greenhouse-Geisser	4944.022	1.709	2892.661	3.710	.038	.113

	Huynh-Feldt	4944.022	1.806	2738.245	3.710	.035	.113
	Lower-bound	4944.022	1.000	4944.022	3.710	.064	.113
Error(articulation*voicing)	Sphericity Assumed	38646.701	58	666.322			
	Greenhouse-Geisser	38646.701	49.566	779.707			
	Huynh-Feldt	38646.701	52.361	738.085			
	Lower-bound	38646.701	29.000	1332.645			
syllablep * articulation * voicing	Sphericity Assumed	12007.799	2	6003.900	8.794	.000	.233
	Greenhouse-Geisser	12007.799	1.805	6650.725	8.794	.001	.233
	Huynh-Feldt	12007.799	1.918	6259.918	8.794	.001	.233
	Lower-bound	12007.799	1.000	12007.799	8.794	.006	.233
Error(syllablep*articulation*voicing)	Sphericity Assumed	39598.489	58	682.733			
	Greenhouse-Geisser	39598.489	52.359	756.286			
	Huynh-Feldt	39598.489	55.628	711.846			
	Lower-bound	39598.489	29.000	1365.465			

Estimated Marginal Means

Syllable position

Estimates

Measure:MEASURE_1

syllablep	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	40.549	3.242	33.918	47.180
2	45.778	3.809	37.988	53.568

Voicing

Estimates

Measure:MEASURE_1

voicing	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	53.670	3.240	47.043	60.297
2	32.657	3.760	24.967	40.348

Place of articulation

Estimates

Measure:MEASURE_1

articulation	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	49.908	3.866	42.001	57.814
2	34.167	3.154	27.716	40.617
3	45.417	3.645	37.962	52.871

Syllable position X place of articulation

Estimates

Measure:MEASURE_1

syllablep	articulation	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	43.148	3.755	35.469	50.828
	2	29.333	3.554	22.065	36.601
	3	49.167	3.972	41.042	57.291
2	1	56.667	5.740	44.927	68.407
	2	39.000	3.599	31.639	46.361
	3	41.667	4.538	32.385	50.948

Syllable position X voicing

Estimates

Measure:MEASURE_1

syllable p	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	43.784	3.340	36.953	50.615
	2	37.315	3.631	29.889	44.740
2	1	63.556	4.018	55.339	71.773
	2	28.000	4.732	18.322	37.678

Place of articulation X voicing

Estimates

Measure:MEASURE_1

articulation	voicing	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	64.260	4.703	54.641	73.878
	2	35.555	5.128	25.068	46.043
2	1	39.667	3.880	31.731	47.602
	2	28.667	3.207	22.108	35.225
3	1	57.083	4.006	48.890	65.277
	2	33.750	4.609	24.323	43.177

Syllable position X place of articulation X voicing

Estimates

Measure:MEASURE_1

syllable p	articulat ion	voicing	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
1	1	1	48.519	3.860	40.625	56.414
		2	37.777	4.282	29.019	46.535
	2	1	35.333	4.567	25.993	44.674
		2	23.333	3.724	15.716	30.950
	3	1	47.500	4.380	38.543	56.457
		2	50.833	4.717	41.187	60.480
2	1	1	80.000	7.428	64.808	95.192
		2	33.333	8.754	15.430	51.237
	2	1	44.000	4.538	34.718	53.282
		2	34.000	4.196	25.418	42.582
	3	1	66.667	6.033	54.328	79.006
		2	16.667	5.536	5.344	27.990

Utterance position

<u>Frequency Table</u>

Statistics

		beginning_k_percentage	middle_p_percentage	middle_b_percentage	middle_t_percentage	middle_d_percentage	middle_k_percentage	middle_g_percentage	end_p_percentage	end_b_percentage	end_d_percentage	end_g_percentage
N	Valid	30	30	30	30	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0	0	0	0	0
Mean		50.0000	50.3717	33.7500	39.6667	27.5000	51.4823	46.6673	60.0000	51.6667	33.3333	37.7760
Median		50.0000	55.5600	25.0000	40.0000	25.0000	55.5600	42.8600	100.0000	50.0000	50.0000	33.3300
Mode		.00[a]	55.56	25.00	30.00[a]	37.50	55.56	42.86	100.00	50.00	50.00	33.33
Std. Deviation		50.85476	20.37205	22.54067	21.25110	19.53114	22.12472	29.28315	49.82729	33.43376	30.32392	24.34419
Minimum		.00	11.11	.00	.00	.00	.00	.00	.00	.00	.00	.00
Maximum		100.00	77.78	75.00	100.00	75.00	100.00	100.00	100.00	100.00	100.00	100.00
Sum		1500.00	1511.15	1012.50	1190.00	825.00	1544.47	1400.02	1800.00	1550.00	1000.00	1133.28
Percentiles	25	.0000	33.3300	21.8750	30.0000	12.5000	33.3300	14.2900	.0000	50.0000	.0000	33.3300
	50	50.0000	55.5600	25.0000	40.0000	25.0000	55.5600	42.8600	100.0000	50.0000	50.0000	33.3300
	75	100.0000	66.6700	50.0000	50.0000	37.5000	66.6700	71.4300	100.0000	62.5000	50.0000	33.3300

a. Multiple modes exist. The smallest value is shown

Types of Errors (MANOVA)

Descriptive Statistics

Descriptive Statistics

	Voiceless/Voiced	Mean	Std. Deviation	N
Target PREno Correct	voiceless	46,13	17,756	30
	voiced	37,73	18,957	30
	Total	41,93	18,696	60
Target PREno INCORRECT VOICELESS	voiceless	3,87	3,235	30
	voiced	24,80	12,358	30
	Total	14,33	13,843	60
Target PREno INCORRECT VOICED	voiceless	11,20	6,840	30
	voiced	2,40	2,253	30
	Total	6,80	6,722	60
Target PREno INCORRECTLY PRENASALIZED	voiceless	,27	1,015	30
	voiced	,67	1,845	30
	Total	,47	1,490	60
Target PREno INCORRECTLY NOT PRENASALIZED	voiceless	,00	,000	30
	voiced	,00	,000	30
	Total	,00	,000	60
Target PREno INCORRECT OTHER	voiceless	2,80	3,178	30
	voiced	3,47	3,893	30
	Total	3,13	3,539	60
Target PREno INCORRECT NO RESPONSE	voiceless	35,33	20,614	30
	voiced	4,00	,000	30
	Total	19,67	21,412	60
Target PRE Correct	voiceless	6,13	4,666	30
	voiced	22,67	22,733	30
	Total	14,40	18,281	60
Target PRE INCORRECT VOICELESS	voiceless	,00	,000	30
	voiced	,67	3,651	30
	Total	,33	2,582	60
Target PRE INCORRECT VOICED	voiceless	1,07	2,083	30
	voiced	,67	3,651	30

	Total	,87	2,954	60
Target PRE INCORRECTLY PRENASALIZED	voiceless	,00	,000	30
	voiced	,00	,000	30
	Total	,00	,000	60
Target PRE INCORRECTLY NOT PRENASALIZED	voiceless	2,93	3,140	30
	voiced	8,00	12,429	30
	Total	5,47	9,344	60
Target PRE INCORRECT OTHER	voiceless	1,33	2,187	30
	voiced	17,33	19,464	30
	Total	9,33	15,926	60
Target PRE INCORRECT NO RESPONSE	voiceless	8,13	4,981	30
	voiced	44,00	32,120	30
	Total	26,07	29,092	60

Tests of Between-Subjects Effects

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	Target PREno Correct	1058,400[a]	1	1058,400	3,138	,082	,051	3,138	,414
	Target PREno INCORRECT VOICELESS	6573,067[c]	1	6573,067	80,561	**1,45E-12**	,581	80,561	1,000
	Target PREno INCORRECT VOICED	1161,600[d]	1	1161,600	44,796	,000	,436	44,796	1,000
	Target PREno INCORRECTLY PRENASALIZED	2,400[e]	1	2,400	1,083	,302	,018	1,083	,176
	Target PREno INCORRECTLY NOT PRENASALIZED	,000[f]	1	,000	.	.	.	.	.
	Target PREno INCORRECT OTHER	6,667[g]	1	6,667	,528	,470	,009	,528	,110
	Target PREno INCORRECT NO RESPONSE	14726,667[h]	1	14726,667	69,315	,000	,544	69,315	1,000
	Target PRE Correct	4100,267[i]	1	4100,267	15,227	,000	,208	15,227	,970
	Target PRE INCORRECT VOICELESS	6,667[j]	1	6,667	1,000	,321	,017	1,000	,166
	Target PRE INCORRECT VOICED	2,400[k]	1	2,400	,272	,604	,005	,272	,081
	Target PRE INCORRECTLY PRENASALIZED	,000[f]	1	,000	.	.	.	.	.

	Target PRE INCORRECTLY NOT PRENASALIZED	385,067[l]	1	385,067	4,686	,035	,075	4,686	,567
	Target PRE INCORRECT OTHER	3840,000[m]	1	3840,000	20,019	,000	,257	20,019	,993
	Target PRE INCORRECT NO RESPONSE	19296,267[n]	1	19296,267	36,528	,000	,386	36,528	1,000
Intercept	Target PREno Correct	105504,267	1	105504,267	312,760	,000	,844	312,760	1,000
	Target PREno INCORRECT VOICELESS	12326,667	1	12326,667	151,079	,000	,723	151,079	1,000
	Target PREno INCORRECT VOICED	2774,400	1	2774,400	106,991	,000	,648	106,991	1,000
	Target PREno INCORRECTLY PRENASALIZED	13,067	1	13,067	5,896	,018	,092	5,896	,666
	Target PREno INCORRECTLY NOT PRENASALIZED	,000	1	,000	.	.	.	.	.
	Target PREno INCORRECT OTHER	589,067	1	589,067	46,658	,000	,446	46,658	1,000
	Target PREno INCORRECT NO RESPONSE	23206,667	1	23206,667	109,229	,000	,653	109,229	1,000
	Target PRE Correct	12441,600	1	12441,600	46,204	,000	,443	46,204	1,000
	Target PRE INCORRECT VOICELESS	6,667	1	6,667	1,000	,321	,017	1,000	,166
	Target PRE INCORRECT VOICED	45,067	1	45,067	5,100	,028	,081	5,100	,603

	Target PRE INCORRECTLY PRENASALIZED	,000	1	,000	.	.	.	.	.
	Target PRE INCORRECTLY NOT PRENASALIZED	1793,067	1	1793,067	21,821	,000	,273	21,821	,996
	Target PRE INCORRECT OTHER	5226,667	1	5226,667	27,248	,000	,320	27,248	,999
	Target PRE INCORRECT NO RESPONSE	40768,267	1	40768,267	77,174	,000	,571	77,174	1,000
Voicing	Target PREno Correct	1058,400	1	1058,400	3,138	,082	,051	3,138	,414
	Target PREno INCORRECT VOICELESS	6573,067	1	6573,067	80,561	,000	,581	80,561	1,000
	Target PREno INCORRECT VOICED	1161,600	1	1161,600	44,796	,000	,436	44,796	1,000
	Target PREno INCORRECTLY PRENASALIZED	2,400	1	2,400	1,083	,302	,018	1,083	,176
	Target PREno INCORRECTLY NOT PRENASALIZED	,000	1	,000	.	.	.	.	.
	Target PREno INCORRECT OTHER	6,667	1	6,667	,528	,470	,009	,528	,110
	Target PREno INCORRECT NO RESPONSE	14726,667	1	14726,667	69,315	,000	,544	69,315	1,000
	Target PRE Correct	4100,267	1	4100,267	15,227	,000	,208	15,227	,970
	Target PRE INCORRECT VOICELESS	6,667	1	6,667	1,000	,321	,017	1,000	,166

	Target PRE INCORRECT VOICED	2,400	1	2,400	,272	,604	,005	,272	,081
	Target PRE INCORRECTLY PRENASALIZED	,000	1	,000	.	.	.	.	.
	Target PRE INCORRECTLY NOT PRENASALIZED	385,067	1	385,067	4,686	,035	,075	4,686	,567
	Target PRE INCORRECT OTHER	3840,000	1	3840,000	20,019	,000	,257	20,019	,993
	Target PRE INCORRECT NO RESPONSE	19296,267	1	19296,267	36,528	,000	,386	36,528	1,000
Error	Target PREno Correct	19565,333	58	337,333					
	Target PREno INCORRECT VOICELESS	4732,267	58	81,591					
	Target PREno INCORRECT VOICED	1504,000	58	25,931					
	Target PREno INCORRECTLY PRENASALIZED	128,533	58	2,216					
	Target PREno INCORRECTLY NOT PRENASALIZED	,000	58	,000					
	Target PREno INCORRECT OTHER	732,267	58	12,625					
	Target PREno INCORRECT NO RESPONSE	12322,667	58	212,460					
	Target PRE Correct	15618,133	58	269,278					

	Target PRE INCORRECT VOICELESS	386,667	58	6,667					
	Target PRE INCORRECT VOICED	512,533	58	8,837					
	Target PRE INCORRECTLY PRENASALIZED	,000	58	,000					
	Target PRE INCORRECTLY NOT PRENASALIZED	4765,867	58	82,170					
	Target PRE INCORRECT OTHER	11125,333	58	191,816					
	Target PRE INCORRECT NO RESPONSE	30639,467	58	528,267					
Total	Target PREno Correct	126128,000	60						
	Target PREno INCORRECT VOICELESS	23632,000	60						
	Target PREno INCORRECT VOICED	5440,000	60						
	Target PREno INCORRECTLY PRENASALIZED	144,000	60						
	Target PREno INCORRECTLY NOT PRENASALIZED	,000	60						
	Target PREno INCORRECT OTHER	1328,000	60						

	Target PREno INCORRECT NO RESPONSE	50256,000	60						
	Target PRE Correct	32160,000	60						
	Target PRE INCORRECT VOICELESS	400,000	60						
	Target PRE INCORRECT VOICED	560,000	60						
	Target PRE INCORRECTLY PRENASALIZED	,000	60						
	Target PRE INCORRECTLY NOT PRENASALIZED	6944,000	60						
	Target PRE INCORRECT OTHER	20192,000	60						
	Target PRE INCORRECT NO RESPONSE	90704,000	60						
Corrected Total	Target PREno Correct	20623,733	59						
	Target PREno INCORRECT VOICELESS	11305,333	59						
	Target PREno INCORRECT VOICED	2665,600	59						
	Target PREno INCORRECTLY PRENASALIZED	130,933	59						
	Target PREno INCORRECTLY NOT PRENASALIZED	,000	59						

	Target PREno INCORRECT OTHER	738,933	59						
	Target PREno INCORRECT NO RESPONSE	27049,333	59						
	Target PRE Correct	19718,400	59						
	Target PRE INCORRECT VOICELESS	393,333	59						
	Target PRE INCORRECT VOICED	514,933	59						
	Target PRE INCORRECTLY PRENASALIZED	,000	59						
	Target PRE INCORRECTLY NOT PRENASALIZED	5150,933	59						
	Target PRE INCORRECT OTHER	14965,333	59						
	Target PRE INCORRECT NO RESPONSE	49935,733	59						

a. R Squared = ,051 (Adjusted R Squared = ,035)

b. Computed using alpha = ,05

c. R Squared = ,581 (Adjusted R Squared = ,574)

d. R Squared = ,436 (Adjusted R Squared = ,426)

e. R Squared = ,018 (Adjusted R Squared = ,001)

f. R Squared = . (Adjusted R Squared = .)

g. R Squared = ,009 (Adjusted R Squared = -,008)

h. R Squared = ,544 (Adjusted R Squared = ,537)

i. R Squared = ,208 (Adjusted R Squared = ,194)

j. R Squared = ,017 (Adjusted R Squared = ,000)

k. R Squared = ,005 (Adjusted R Squared = -,013)

l. R Squared = ,075 (Adjusted R Squared = ,059)

m. R Squared = ,257 (Adjusted R Squared = ,244)

n. R Squared = ,386 (Adjusted R Squared = ,376)

G Descriptive Statistics for the Words-in-Sentences Identification task concerning performance of participants in terms of the four investigated factors in descending order (better performance in voiceless plosives).

	Rank Order	***M(SD)***	**N**
PPVPAWS			
Variable 1: word-final coda [p]	1	80.00(40.68)	30
Variable 2: word-final coda [k]	2	66.67(33.04)	30
Variable 3: word-initial onset [p]	3	59.44(24.24)	30
Variable 4: word-initial onset [k]	4	58.33(28.87)	30
Variable 5: word-initial onset [g]	5	56.67(30.04)	30
Variable 6: word-initial onset [b]	6	50.00(29.68)	30
Variable 7: word-medial onset [g]	7	44.17(29.86)	30
Variable 8: word-medial onset [k]	8	36.67(26.04)	30
Variable 9: word-final coda [b]	9	33.33(47.95)	30
Variable 10: word-medial onset [p]	10	27.78(23.30)	30
Variable 12: word-final coda [g]	11	16.67(30.32)	30
Variable 13: word-medial onset [b]	12	12.22(18.53)	30

PPVPAWS = Participants' Performance in terms of Voicing, Place of Articulation, Word position, and Syllable position

% correct