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PERCEPTION AND PRODUCTION OF WORD-FINAL VOWEL EPENTHESIS BY BRAZILIAN EFL STUDENTS

por

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To
Risoleta
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with love and gratitude.

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ABSTRACT

PERCEPTION AND PRODUCTION OF WORD-FINAL VOWEL EPENTHESIS BY BRAZILIAN EFL STUDENTS

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2002

Supervising Professor: Dr. Barbara Oughton Baptista

This research focuses on the occurrence of a pronunciation error – vowel epenthesis in word-final consonant codas produced by Brazilian learners of English. The relationship between production and perception was established by investigating the ability to produce word-final consonants and to discriminate ##CVC## and ##CVCV## sequences where the final vowel is /i/. Twenty learners from the first and second semesters of undergraduate courses at three universities were tested. Following Baptista and Silva Filho (1997), epenthesis production was examined in three variables of markedness of the target consonant and two variables of phonological environment: (a) voicing of the target consonant, (b) relative markedness within the class of obstruents, (c) relative markedness among voiced stops by place of articulation, (d) phonological context as consonants, vowels, or silence, and (e) sonority relations across syllables. The relationship between perception and production was assessed in terms of variables (a) and (e) above, and in general terms to establish the degree of association between the two abilities. Production data was obtained through the reading of sentences containing ##CVC## sequences in the context of ##CVC(C)##, ##VC(C)##, and silence. Perception data was obtained through an oddity discrimination test (Flege,

MacKay, & Meador, 1999). In general, the statistical analyses revealed no significant effect of markedness of the target consonant or phonological context in epenthesis production and perception; however, tendencies could be identified both comparing the production results with those of previous research and in the association of the production and perception data investigating these variables. Support for the hypothesis on the perception-production relationship was provided by statistically significant results indicating association between the two abilities. These results may be taken to argue in favor of the syllable as the underlying unit of representation guiding BP speakers' perception and production of L2 word-final consonant codas.

208 pages (excluding appendix)
63,076 words (excluding appendix)

RESUMO

PERCEPÇÃO E PRODUÇÃO DA EPENTÊSE VOCÁLICA NO FINAL DE PALAVRAS POR ESTUDANTES BRASILEIROS DE INGLÊS.

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Esta pesquisa focaliza a ocorrência de um erro de pronúncia – a epêntese vocálica em consoantes em final de palavras no inglês de estudantes brasileiros. A relação entre produção e percepção foi estabelecida a partir da investigação sobre as habilidades de produzir consoantes em final de palavra e de discriminar seqüências ##CVC## e ##CVCV## onde a vogal final é /i/. Vinte estudantes do primeiro e segundo semestres de cursos de graduação em três universidades participaram do estudo. Seguindo-se a linha de pesquisa de Baptista e Silva Filho (1997), a produção da epêntese foi examinada através de três variáveis de marcação da consoante-alvo e duas variáveis de contexto fonológico: (a) vozeamento, (b) marcação relativa na classe de obstruintes, (c) marcação relativa das plosivas vozeadas por ponto de articulação, (d) silêncio, consoante ou vogal como contexto fonólogico, e (e) relações de sonoridade entre as sílabas. A relação entre produção e percepção foi examinada em termos das variáveis (a) e (e) acima e em termos gerais, estabelecendo-se o grau de associação entre as habilidades. Os dados de produção foram obtidos através da leitura de sentenças

contendo seqüências ##CVC## em contexto de seqüências ##CVC(C)##, ##VC(C)##, e silêncio. Os dados de percepção foram obtidos através de um teste de discriminação do item estranho (Flege, MacKay e Meador, 1999). Em geral, as análises estatísticas não revelaram efeito significativo da marcação da consoante final ou do contexto fonológico na produção e percepção, entretanto, tendências foram identificadas ao se estabelecer comparação entre os resultados de produção e resultados de pesquisas anteriores, e entre os dados de produção e percepção investigando estas variáveis. A análise estatística dos dados, estabelecendo relação entre percepção e produção, mostrou resultados significativos indicando associação entre as habilidades. Propõe-se que tais resultados argumentam em favor da sílaba como unidade de representação mental guiando a percepção e produção de consoantes em final de palavras em L2.

Nº de páginas: 208
Nº de palavras: 63.076

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ABBREVIATIONS

AE	American English
AOA	Age of arrival (in the L2 country)
AOL	Age of learning
BP	Brazilian Portuguese
CPH	Critical Period Hypothesis
CDT	Categorial Discrimination Test
EP	European Portuguese
FA	False alarm
HAS	High Amplitude Sucking
HIT	Correct indication of the odd item out in the CDT
IL	Interlanguage
IPA	International Phonetic Alphabet
L1	First language
L2	Second/foreign language
MDH	Markedness Differential Hypothesis
NL	Native language
OT	Optimality Theory
SCL	Syllable Contact Law
SCN	Syllable Contact Number
SLM	Speech Learning Model
SSC	Syllable Structure Condition
SSG	Sonority Sequencing Generalization
UR	Underlying Representation
VOT	Voice Onset Time

CONVENTIONS

V	=	vowel
C	=	consonant
$	=	syllable boundary
##	=	word boundary
[']	=	primary stress
/.../	=	phoneme
[...]	=	phone
(...)	=	optional
⊃	=	implies
O/N/L/G	=	obstruent/nasal/liquid/glide
Vd	=	voiced
Vl	=	voiceless
cont	=	continuant
cons	=	cononantal
nas	=	nasal
son	=	sonorant
syll	=	syllabic
~		nasality
̯		glide

In quotations and when referring to an author, the notations or transcriptions used by the author were maintained.

SYMBOLS USED FOR BRAZILIAN PORTUGUESE CONSONANTS

p =	pai	father	
b =	bola	ball	
t =	tia	aunt	
tʃ =	tia		* dialectal
d =	dia	day	
dʒ =	dia		* dialectal
k =	capa	cover	
g =	gato	cat	
f =	faca	knife	
v =	vaca	cow	
s =	sapo, passo	frog, step	
ʃ =	chá, cacho	tea, lock	
z =	zona, casa	zone, house	
ʒ =	já, hoje	yet, today	
[S] =	pasta, mas, rasga	paste, but, tear	(in this dissertation for the syllable-and word-final /s/[1])
[R] =	rosa, mar, carro	pink, sea, car	(in this dissertation for the strong R[2])
ɾ =	aro, prato	hoop, plate	
m =	mãe	mother	
n =	nata	cream	
ɲ =	nhame, banho	nhame, bath	
l =	lata, mala	can, bag	
ɬ =	mel	honey	* dialectal
ʎ =	lhama, molhar	llama, wet	
k^w =	Quase	almost	
g^w =	Igual	equal	

[1] See Section 2.4.2.
[2] See Section 2.4.2.

SYMBOLS USED FOR BRAZILIAN PORTUGUESE VOWELS

i	=	vi	I saw
e	=	vê	he/she sees
ɛ	=	fé	faith
a	=	dá	he/she gives
ɔ	=	vó	grandma
o	=	vô	grandpa
u	=	tu	you
ɐ	=	bol<u>a</u>	ball
ʊ̯	=	seu	your, yours
ɪ̯	=	lei	law

CHAPTER 1

INTRODUCTION

1.1 Background to the study

Over the past three decades interlanguage (IL) phonology studies have been building up an emerging body of research data to consolidate phonological theory and foster pedagogical improvement. From work centered on contrastive analysis underpinned on the belief that foreign language mispronunciations were exclusively due to first language (LI) interference – the phenomenon of negative transfer – research tendencies have evolved to incorporate investigations of internal linguistic and external stylistic, social, psychological and cognitive constraints that may operate, either independently or in interaction, in structuring IL phonology.

Especially abundant has been phonological research on internal linguistic constraints concerning the role of markedness relationships in L2[1] syllable structure acquisition (e.g., Anderson, 1983/1987; Baptista & Silva Filho, 1997; Broselow, 1983/1987a, 1984/1987b; Eckman, 1981, 1987b, 1991; Eckman & Iverson, 1993, 1994; Edge, 1991; Hancin-Bhatt, 2000; Major & Faudree, 1996; Rebello, 1997; Tarone, 1980/1987; Tropf, 1987; Weinberger, 1987). In general, these studies examined the phenomena of consonant cluster reduction and of vowel epenthesis after single-consonant codas as a result of the preference for the universal CV syllable, referring to the influence of implicational universals on L2 phonology acquisition.

[1] L2 is used here as a 'general' term, referring to second/foreign language. When referring specifically to the English of Brazilian learners involved in the present study the term should be read 'foreign language'.

According to Carlisle (1994), another important internal linguistic constraint affecting phonological production is the linguistic environment. The studies of L. Dickerson (1975); W. Dickerson (1976/1987); Dickerson & Dickerson (1977); and Gatbonton (1978) in the 1970s are pointed out by the author as giving the lead to research investigation of the influence of a consonant, a vowel, or a pause as the environment of an L2 variable. Following this current, Carlisle (1991a, 1991b, 1992, 1997, 2001) has focused on the production of /sC/ onsets in the English of L1 Spanish speakers. Baptista and Silva Filho (1997) and Rebello (1997) go a step further and examine the interaction of markedness relations and phonological environment dealing with markedness relations across syllables, where differences in sonority between the target sound and the phonological environment are taken into account as a factor for promoting vowel epenthesis in consonant codas and /sC/ onsets, respectively, in the English of Brazilian Portuguese speakers.

The role of external linguistic constraints in phonological variability has been explored in the often cited work on style-shifting of the Dickersons (L. Dickerson, 1974, 1975; W. Dickerson, 1976/1987; Dickerson & Dickerson, 1977), and in the work of Beebe (1977a, 1977b, 1980/1987), Sato (1985), Schmidt (1977), Tarone (1979, 1982, 1983), among others (see reviews in Beebe, 1988; Major, 1994a; and Tarone, 1988).

A growing interest in cognitive/psychological factors affecting language acquisition and development has triggered investigations of learning styles and strategies, learner's attitudes, motivation, age and sex (see Leather & James, 1996 for a review), and also investigations of the relationship between L2 speech perception and production. Among other objectives, research on this relationship is expected to reveal the nature of the information involved in L2 speech processing. The work developed by James Emil Flege's research group in the Speech and Hearing Laboratory at the

University of Birmingham has been particularly influential in the field (Flege, 1995; Flege, Munro & MacKay, 1995a, 1995b; Flege, MacKay & Meador, 1999; among others).

Investigations of the role of intra and extra-linguistic constraints in L2 phonological performance typically involve systematic deviant productions – in general, the inappropriate employment of phonological processes such as vowel lengthening, strengthening of glides, consonant devoicing, and resyllabification with vowel or consonant deletion or addition – the process of vowel epenthesis.

In line with these investigations, the present study examines the occurrence of a phonological error – vowel epenthesis in word-final consonant codas of Brazilian speakers of English as a foreign language – based on the theoretical and empirical background provided by work in the areas of (a) phonological theory of the syllable, (b) markedness relations and phonological environment in error production, and (c) the relationship between perception and production in IL phonology.

Epenthesis is the insertion of a segment, vowel or consonant, into an existing string of segments. The terms 'prothesis' and 'paragoge' refer to vowel epenthesis in the beginning and end of words, respectively. As a norm of the two respective languages, Arabic and German epenthesize a glottal stop [ʔ] in the onset position. Historically, epenthesis processes have been present in the development of many languages, such as in the Latin clusters /sp st sk/, which gained initial-vowel /e/ epenthesis in Old French, and Old English forms like æmtig and þunor which developed into *empty* and *thunder* (Roca & Johnson 1999; Trask, 1996).

McCarthy and Prince (1993) define epenthesis in the perspective of Optimality Theory (OT) as a phenomenon determined by prosodic parsing, where "the syllable

parse posits segmentally unfilled structural positions, which receive a default interpretation as some actual segment, such as *a* or *i*, *t*, or ʔ" (p. 37).

In English, vowel epenthesis is a common phonological process involved in the pluralization of words ending in sibilants (e.g., *place/places* [pleɪsɪz]), in the past tense of regular verbs ending in alveolar stops (e.g., *plant/planted* [plæntɪd]), and in certain non-standard pronunciations such as *athletic* [æθəlɛtɪk] and *film* [fɪləm]. Consonantal epenthesis occurs in the insertion of [t], [p], or [k] in the pronunciation of words like *prince* [prɪnts], *since* [sɪnts], *comfort* [kʌmpfɚt], and *length* [lɛŋkθ] (Lass, 1984; Trask, 1996; and see Clements, 1987 for a comprehensive description of intrusive stops in English).

In BP, unacceptable sequences of obstruents within words and final syllable obstruents in acronyms are avoided by the insertion of an [i]. Common examples of these sequences appear in the pronunciation of words such as: *ritmo* [ˈRitimu] – 'rhythm', and *objeto* [obiˈjɛtu] – 'object' (see Section 2.5 for further examples). Acronyms such as *MEC* (*Ministério da Educação e Cultura*) – 'Ministry of Education and Culture', *UFSC* (*Universidade Federal de Santa Catarina*), 'Federal University of Santa Catarina', and *MASP* (*Museu de Arte Moderna*) – 'Museum of Modern Art' are pronounced as [ˈmɛki], [ˈufiSki], and [ˈmaSpi], respectively. Furthermore, epenthesis is a productive process in Brazilian Portuguese, since it operates in loanwords to make them conform to the CV pattern of the language (e.g., *surfe* [ˈsuRfi] – 'surf', *pique-nique* [pikiˈniki] – 'pic-nic', *futebol* [futiˈbɔʊ̯] – 'football'). Anecdotal data is rich in pets named after famous American 'characters' such as *Maki* [ˈmaki] – (short for

McDonalds) and *Bredy* [brɛdi] – (named after the actor Brad Pitt). Acronyms also conform to the CV norm by including the vocalic segment of the words involved to form speaker-friendly sequences such as in *Fecasurfe* (*Federação Catarinense de Surfe*) – 'State of Santa Catarina Surfers' Association', and *Sudene* (Superintendência do Desenvolvimento do Nordeste) – 'Supervising Organization for the Development of the Northeast'.

In the field of IL, the literature on epenthesis production includes investigations of the production of initial and final consonant clusters and of word-final single-consonant codas. This literature has been specially fertile in explorations of Spanish contact with a variety of L2s (e.g., Spanish and Swedish – Abrahamsson, 1997, 1999; Spanish and Italian – Schmid, 1997; Spanish and German – Tropf, 1987; Spanish and English – Carlisle, 1991a, 1991b, 1992, 2001), and in exploring a variety of L1s in contact with English (e.g., Anderson, 1987; Broselow, 1983/1987a; Broselow, Chen & Wang, 1998; Eckman, 1987b, 1981/1987c, 1991; Hancin-Bhatt, 2000; Karimi, 1987; Major, 1987a, 1987b, 1992, 1994a, 1996; Ross, 1994; Sato, 1984/1987; Tarone, 1980/1987; Weinberger, 1987).

To date, there has been only a limited number of IL phonology studies involving Brazilian speakers, but the resulting data has proved to be enlightening. Tarone (1980/1987) showed that while Cantonese and Korean speakers simplified English syllable structure by consonant deletion, Brazilians favored the insertion of a vowel following the final consonant. She discusses the results in terms of three processes affecting IL syllable structure: transfer, reactivated L1 acquisition processes, and universal processes. Her work seems to have established the field for research in the area.

Major (1986) related degree of foreign accent to epenthesis production in word-

final consonants. Subsequent work of Major (1987a, 1992, 1994b, 1996) investigated single-consonant codas and initial and final consonant clusters aiming at testing his Ontogeny Model of second language phonological acquisition. The model proposes an interrelationship between transfer and developmental processes, in which while the former processes predominate at an early stage, the latter increase and then decrease over time. Thus, vowel epenthesis realized as [i] by beginning speakers of English can be considered a transfer process, since it occurs in BP words. Then, gradually, the epenthetic [i] is replaced by [ə] as a developmental process typical of L1 acquisition.

Data from Fernandes (1997), collected with 30 Brazilian students, also indicated this tendency, since there seemed to be a relationship between production of [i] and [ə] and language proficiency. While the model and its hypotheses remain open to longitudinal investigations, these studies have shown that undoubtedly, vowel epenthesis is employed with considerable frequency by Brazilians speaking English.

Baptista and Silva Filho (1997) and Rebello (1997) set out to investigate final single consonant codas and initial /s/-clusters, respectively. These studies analyze the occurrence of the epenthetic vowel in relation to NL transfer and universals of syllable structure, markedness relations, phonological environment, and sonority relations across syllable boundaries. In general, the results of both studies indicate that NL transfer interferes with the degree of influence of universal markedness conditions and with environmental constraints on IL epenthesis production.

Finally, Monahan (2001) aimed at answering the question: "Do native speakers of BP epenthesize to make their English utterances well-formed BP syllables?", applying the OT framework.

1.2 Statement of purpose

The present study pursues the lines of research of Baptista and Silva Filho (1997) (see Section 2.6) with respect to the linguistic variables investigated. First it aims at examining the generalizability of the findings reported in their study by replicating the measures with a larger group of subjects. Specifically, the variables replicated here are (a) voicing of the target consonant, (b) relative markedness within the class of obstruents, (c) relative markedness among voiced stops by place of articulation, (d) phonological contexts, and (e) sonority relations across syllables.

Second, in line with the work being developed by Flege and colleagues (e.g., Flege, 1995; Flege, Munro & Fox, 1994; Flege, Mackay & Meador, 1999) this study seeks to offer insight into both the relationship between perception and production in vowel epenthesis following word-final single-consonant codas, and the discussion of the status of the syllable as a unit of perceptual analysis.

1.3 Significance of the study

The contributions of this dissertation, from the point of view of intralinguistic investigations in the area of markedness relations and phonological environment, consist of bringing new data to be integrated into the stimulating discussion of the influence of transfer and markedness relations in structuring IL phonology, and of helping to consolidate a new area of markedness that needs to be examined – the area of sonority differences across syllables as an environmental factor – pointed out by Baptista and Silva Filho (1997).

With respect to the question of the relationship between L2 speech perception and production, the present study is innovative in that up to now, investigations focusing on the issue have dealt with distinctions between similar phonemes, whereas this study deals with syllable structure and the presence or absence of an additional phone. A further contribution of this study is to be seen in terms of its helping to define the underlying unit of representation of the speech signal guiding the production of word-final consonant codas. The recentness of an ongoing interest in the phonetic representational unit/s on which L2 speakers rely in producing particular language items, and the scarcity of the literature on non-segmental L2 phonological performance lend particular importance to this research.

Finally, in a broader sense, this study, as other studies of systematic L2 learners' productions, is expected to offer testing grounds for the refinement of linguistic and psycho-pedagogical theories. As traditional theories based on the adult monolingual speaker fail to account for the fact that modern linguistic societies cannot be characterized by monolingualism, new developments in these theories are surely welcome.

1.4 Organization of the dissertation

This dissertation consists of 7 chapters. Chapters 2, 3, and 4 present an overview of the literature on the three major background areas that set the field for the study carried out to assess the relationship between perception and production of word-final consonants in the English of BP speakers.

Chapter 2 starts by exploring the concept of the syllable as a phonetic and

phonological unit focusing on Hooper's (1972, 1976) framework to establish a definition of the syllable, and on Murray and Vennemann's (1983) extension of Hooper's condition for cross-syllabic contacts; then, it describes the structures of the BP and English syllables, with special attention to the composition of the codas; and finally, it describes the phenomenon of epenthesis production both in Brazilian Portuguese and in the English interlanguage of Brazilian Portuguese speakers.

Chapter 3 describes the theoretical foundations for hypotheses in phonological research concerning markedness relations, and reviews studies investigating markedness relationships and phonological environment in L2 syllable structure acquisition, focusing on research that contributed to build the framework of the present dissertation. Special attention is given to Baptista and Silva Filho's (1997) and Rebello's (1997) studies because they are the two studies most directly related to this dissertation both in terms of design and outcomes.

Chapter 4 presents an overview of theoretical issues and empirical findings concerned with the question of the relationship between perception and production in L2 speech, with reference to the framework of the Speech Learning Model (SLM) of Flege and colleagues (Flege, 1995). The chapter also addresses the question of the identification of the mental unit of speech perception and production, and presents an overview of the main lines of research on the relationship. Finally, it briefly describes the speech perception assessment techniques most frequently employed in recent research, with special attention to the description of the perception test employed in this study, the categorial discrimination test (CDT).

Chapter 5 describes the method used in the research carried out for this dissertation, including the research questions and hypotheses investigated, and the statistical procedures used to analyze the data gathered.

Chapter 6 reports on the data obtained and the results of the statistical analyses carried out in the study, and discusses the results with reference to the research questions and hypotheses formulated in Chapter 5, relating the outcomes to the literature underpinning the dissertation. It also considers the effect of the data elicitation task on the linguistic outcome expected or observed.

Chapter 7 comments on the theoretical implications of the study, presents the limitations and suggests directions for further research, and remarks on the pedagogical implications of the outcomes to L2 final-consonant learning.

CHAPTER 2

THE SYLLABLE

2.1 Introduction

The purpose of this chapter is twofold: First, it seeks to explore the concept of the syllable as a phonetic and phonological unit focusing on Hooper's (1972, 1976) framework to establish a definition of the syllable, and on Murray and Vennemann's (1983) extension of Hooper's condition for cross-syllabic contacts. Second, it sets out to describe the structures of the English and the BP syllables, with special attention to the composition of the codas in order to provide insight into the phenomenon of epenthesis production by Brazilian speakers of L2 English.

2.2 The syllable in phonological theory

The psychological reality of the syllable may find support not only in poetry rhyming, in anecdotal data on slips of the tongue, and in speech play used by children as secret codes, but also in rigorous empirical studies investigating first and second language acquisition and development, speech pathology, and phonological change (Cabral, 1985; Cutler, Mehler, Norris, & Segui, 1986; Ladefoged, 1982, Mateus & d'Andrade, 2000).

In general, intuitive recognition of sequences of phonemes as possible or impossible syllabic realizations in a language is not a problem for native speakers;

however, authors stress the lack of a satisfactory definition of the syllable as a linguistic unit (Anderson, 1974; Goldsmith, 1990; Ladefoged, 1982; Hooper, 1972; Laver, 1994, among others). The problem seems to be to find a definition that would be equally valid at a phonetic and phonological level.

Phonetically, the syllable has been associated with respiratory movements – '*chest pulses*' (the articulatory or chest-pulse theory), and with peaks of resonance in the sound stream (the acoustic or prominence theory). Both perspectives are believed to present problems. The former is criticized for lack of empirical support and the latter for lack of a direct coincidence, in many cases, between peaks of acoustic energy and number of syllables (Ladefoged, 1982; Lass, 1984; Wolfram & Johnson, 1982). Lass argues that a phonetic definition in acoustic terms may be appropriate for syllable-timed languages, but not for stress-timed languages where foot boundaries and syllable boundaries may or may not coincide. Drawing on Catford (1977), the author suggests that a universal phonetic definition for the syllable may be possible if based on rhythmic principles, since "all languages have an inherent rhythmic organization, based on the emission of timed initiator power-bursts, each burst having a single peak" (p. 250). However, if such a definition makes it possible to locate syllable peaks, it does not indicate where the boundaries between syllables are to be placed. In 1956, Haugen (cited in Goldsmith, 1990, p. 103) acknowledged the difficulty phoneticians encounter in agreeing on a definition for the syllable. Almost four decades later, Laver (1994) still qualifies the issue of a phonetic definition of the syllable as a perennial concern for phoneticians, the main difficulty being the lack of success in showing "demonstrable, objective correlates on physically measurable parameters" (p. 113).

Phonologically, the status of the syllable and its role in speech production and perception have been stated, challenged, neglected, and re-stated in the domain of

different phonological models, offering a number of alternative proposals (see Souza, 1998 for a comprehensive phonological description of the syllable according to the different theories). In the structuralist perspective of the classic works of Saussure (1915) and Bloomfield (1933) the syllable was defined in terms of the features of its constituents – degree of opening and degree of sonority, respectively – which, as observed by Hooper (1976), are similar classifications. The potential focus of phonological analysis was the phoneme, however, and structuralists did not develop a technique for syllable interpretation as they did for isolated segments. After being neglected in the realm of Transformational-Generative Phonology, the concept of the syllable was recaptured by Natural Generative Phonology, with the expression of elaborate definitions in terms of sequential constraints on constituents (e.g., Hooper, 1972; Selkirk, 1980).

The one fundamental proposal for a formal definition of the syllable as a phonological unit from the perspective of Natural Generative Phonology is that of Hooper (1972). Hooper builds her suggestion of a universal definition of the syllable in terms of conventions for syllable-boundary insertions, relying on examples from Spanish and citing evidence from Chinese (Wang, 1967), Finnish (Harms, 1964), and Germanic languages (Vennemann, 1968). Her universal "$-boundary insertion rule" is stipulated as follows:

$$\emptyset \rightarrow \$ \;/\; [+\text{syll}] \left\{ \begin{array}{ll} \_\_ & [-\text{syll}]_0^1 \\ [-\text{syll}]_0 \_\_ & \left\{ \begin{array}{ll} [-\text{son}] & \left[\begin{array}{l} +\text{son} \\ -\text{nas} \end{array} \right]_0 \\ [+\text{cons}] & [-\text{cons}]_0 \end{array} \right. \end{array} \right\} [+\text{syll}]$$

(Hooper, 1972, p. 536)

The rule states that a syllable boundary is inserted in one of the following environments: (a) between two syllabic segments; (b) between a syllabic segment and a non-syllabic segment that separates two syllabic segments; (c) between a syllabic segment followed by a non-syllabic segment and an obstruent followed by a liquid or a glide and a syllabic segment; (d) between a syllabic segment followed by a non-syllabic segment and a consonantal segment followed by a non-consonantal segment and a syllabic segment.

It is observed that the above formalization as universal is possible because it is made on a phonological basis, and in most languages of the world there is a strong correspondence between the phonological and the phonetic levels. However, for languages where the two levels do not correspond, "additional late rules" may be necessary to account for the exceptions, that is, the language-specific phonetic factors (Hooper, 1972, p. 536). This is the case of English, where stress placement rules are applied after syllabification rules, in contrast to Spanish and German, where the two levels are similar. Hooper complements the rule above with a rule that inserts syllable boundaries at the beginning and end of words:

$$\emptyset \longrightarrow \$ \; / \; \left\{ \begin{array}{r} \#\# \_\_\_\_\_ [+\text{segment}] \\ [+\text{segment}] \_\_\_\_\_ \#\# \end{array} \right\}$$

(Hooper, 1972, p. 537)

Redenbarger (1981) and Lass (1984) criticize Hooper's claims for the universality of her syllable-boundary insertion rule on the grounds of its inadequacy to account for what the author characterizes as exceptions. Lass remarks that there seems to be arbitrariness in these cases, and that Hooper's approach does not account for the possibility of phonetic and phonotactic evidence for syllable boundary insertion.

According to Collischonn (1999) Hooper's approach is one of the two basic

approaches adopted on syllable boundary insertion programs: the rules approach and the conditions approach. The first inserts boundaries by means of rules that create the nucleus, the onset, and then the coda in sequence. The second, adopted by Hooper (1972), inserts boundaries automatically, following determined conditions not ordered within themselves. These conditions may be universal or parametric, allowing different possibilities, as each language makes its own choices. These parametric conditions are the syllable frame and the filters.

Hooper proposes the model as a "first approximation" to a universal generalization, remarking on the need for questioning the appropriateness of defining the syllable by means of a boundary-insertion rule. In defining the syllable in terms of sequences of constituents, Hooper (1976) makes use of the concept of consonantal strength to express hierarchical relations between these constituents. Since strength and sonority are antonyms, a hierarchy established in terms of strength relations results in a ranking that corresponds inversely to those ordered by sonority and openness. Traditionally, the notion has been discussed in the literature in terms of sonority; however, the lack of an explicit conceptualization for this feature is frequently pointed out. Ladefoged (1982) states that "the sonority of a sound is its loudness relative to that of other sounds with the same length, stress, and pitch" (p. 221). Selkirk (1984) remarks that there is an evident phonetic basis for sonority, probably corresponding roughly to loudness. However, the definition of the acoustic parameter depends on linguistic analysis. Clements (1990) characterizes the concept as "ill-defined if not mysterious", proposing that it cannot be defined as a primitive feature, but in terms of other features, as a derivative notion, taken as a function of the sum of the plus-specifications for each major class feature as in the chart (adapted here):

O	<	N	<	L	<	G	
-		-		-		+	Vocoid
-		-		+		+	Approximant
-		+		+		+	Sonorant
0		1		2		3	Rank (relative sonority)

(Clements, 1990, p. 292)

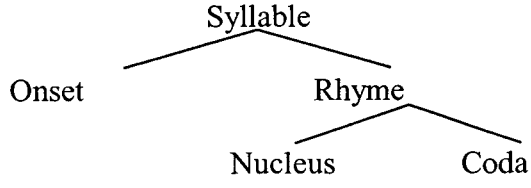
Hooper (1976) relates strength to vowel-likeness. In her terms the strongest consonants are the least vowel-like, whether the particular parameter considered is sonority or openness. She remarks that there is no intention to postulate some absolute physical correlate to strength or to the syllable by analyzing them in terms of physical parameters. Previous attempts to establish consonantal strength hierarchies taking into account a single phonetic parameter and to locate syllable boundaries based exclusively on physical criteria did not succeed. However, she observes that the existence of consonants and vowels is not denied just because of the fact that it is also impossible to identify the boundaries between individual segments on a purely physical basis. Hooper concludes that she views "the syllable, and for that matter the cover feature strength, as theoretical constructs, not entirely divorced from physical reality, but abstract in that their importance is seen only in their function in a linguistic system" (198).

Characterized in the literature as a controversial and hotly debated subject (e.g., Hammond, 1997; Murray & Vennemann, 1983) the definition of the syllable in phonological theory will surely continue to trigger interesting discussions. In this sense, Lass's (1984) proposal seems to be particularly pragmatic. He affirms that first, the independence or interrelation of the definitions of the syllable at the phonetic and phonological levels must be resolved; then, the primitivity of the syllable as a phonological unit capable of fostering linguistic generalizations has to be established; and finally, these two requisites being fulfilled, the "tricky problem of placing syllable

boundaries" may be faced (p. 262).

2.3 Syllable structure and syllable contact

According to Metrical Theory, the syllable consists of two basic phonological parts: the onset, and the rhyme, which is in turn divided into a nucleus, or peak, and a coda. Traditionally, this internal structure is represented in the following tree diagram:



One major differentiation in syllable types is made in terms of the fulfillment of the two slots in the rhyme. Syllables bearing the complete rhyme (nucleus plus coda) are called closed syllables, and syllables where the rhyme carries only the nucleus are called open syllables. The nucleus is the only obligatory constituent. Languages differ in the possibility of branching of the nodes and in the syllabic structures allowed, in terms of number and features of the constituents of onsets and codas. In Goldsmith's (1990) words, "the syllable is a phonological constituent composed of zero or more consonants, followed by a vowel [the nucleus], and ending with a shorter string of zero or more consonants" (p. 108). The invariability of the phonological nucleus may be broken in marked cases – in the occurrence of diphthongs, and of syllabic consonants in some languages. The obligatoriness of onsets and codas varies among languages in the following way: (C)V(C) – English; CV(C) – Yawelmani and Klamath; (C)V – Hawaiian, Maori and Japanese (disregarding syllabic nasals); CV – Senufo (Clements &

Keyser, 1983; Hammond, 1997; Katamba, 1989). Hammond emphasizes that there are no languages that require the (C)VC structure, that is, no languages where closed syllables are obligatory.

The four most basic types of syllable structures are: the V, the CV, the VC, and the CVC (Laver, 1994; Roca & Johnson, 1999). The CV, the open syllable, is the simplest and most frequent syllable structure. It is considered the core syllable as there is no language that does not allow it and in many of them it is the only possibility. Also, acquisitional data shows that it is also the first syllable structure learned by children (Jakobson, 1941; Jackobson & Halle, 1956, both cited in Hooper, 1976, p. 199).

Roca and Johnson formalize an implicational hierarchy of syllable types in this way: VC $\supset$ CVC / V $\supset$ CV, claiming that this hierarchy finds support in data from a number of unrelated areas. The authors say that

> children acquire the different syllable types in precisely the order predicted by the hierarchy; the presence of a more complex type in any one language presupposes the presence of its simpler counterpart(s); syllable-related historical change tends to go in the direction of greater syllable simplicity; in languages with a rich range of syllable patterns, simpler syllables are more frequent, both statically, in inventory, and dynamically, in actual language use; and so on. (p. 247)

Variation in syllable structure is not limited to the presence or absence of the four basic syllable types; but it occurs even more importantly in terms of phonotactic constraints on the syllable constituents. These constraints, posited in terms of differences in strength (sonority) relations among segments, operate on the onsets and codas, and much effort has been devoted, in linguistic history, to the establishment of universal generalizations regarding them. Attempts to define optimal syllable structures in this fashion have appeared in a long tradition of proposals dating back to Sievers (1881; see Istre, 1981 and Clements, 1990, for overviews).

Governing most of these attempts is the notion expressed in the *Sonority*

Sequencing Generalization – also known as the *Sonority Principle* (SSG) – that "in any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values" (Selkirk, 1984, p. 116). Hooper (1976) depicts this intrinsic relation of segments as follows:

MARGIN			NUCLEUS			MARGIN	
obstruents	nasals	liquids	glides	vowels	glides	liquids	nasals obstruents
Least vowel-like			Most vowel-like			Less vowel-like[2]	
STRONG			WEAK			WEAK	

(p. 199)

In the long practice of ranking speech sounds in terms of sonority relations, different hierarchical scales have been proposed. Istre (1981) identifies two approaches in establishing hierarchies. In one approach, segments are assigned intrinsic properties according to diachronic and synchronic processes occurring in natural languages. In the other approach, relative properties are assigned to segments according to word or syllable position. Some formulations of hierarchies adopt a more general criterion, whereas others present subdivisions incorporating a wider array of features and propose language-specific variations. In this latter type, major tendencies can be noted: (a) there is a common underlying ranking order governing the scales, the order of the 'more general' formulations, posited in terms of major class features, with sonority values decreasing from glides to liquids, nasals, and obstruents ([+son]G>L>N>O[-son]); (b) there is a tendency for voicing differences to be considered, and for affricates not to be included explicitly in the scales (exception: Goldsmith's 1990, p. 111 scale, in which affricates are ranked between fricatives and stops); and (c) much of the discussion about the rankings focuses on the placement of obstruents and fricatives in terms of the importance of the features continuancy and voicing, and on the universality of the

[2] Syllable initial-position is considered stronger than syllable-final position.

proposals. Following these more detailed versions, Hooper (1976) establishes a universal strength hierarchy:

glides	liquids	nasals	Vd continuants	Vl continuants Vd stops	Vl stops
1	2	3	4	5	6

(p. 206)

Diachronic and synchronic phonological data are presented as evidence, independent of syllable structure, that voiceless consonants are stronger than voiced consonants, stops stronger than spirants, non-nasals stronger than nasals, and nasals stronger than liquids and glides. The universality of the hierarchy is said not to be absolute in that universal tendencies may suffer minor deviations provoked by language-specific strength relations, which may be explained by phonetic factors. The author relates two particular points in the scale to these language-specific phonetic factors. First, although one of the basic premises of the ranking is the voicing differences, Hooper ranks voiceless continuants and voiced stops together for lack of evidence to establish a universal strength relation between the two classes, observing that there are two possibilities for such a parity. Either there is no significant difference between these sounds, or differences are due to language-specific phonetic and historical factors. Second, the absence of affricates on the scale is justified by the lack of evidence to determine a position for the sounds, which may vary among different languages. Hooper suggests that, due to their articulatory complexity, and to the fact that in some languages strengthening processes shift stops to affricates, these consonants must be ranked in the highest position, and the voicing relation would operate on them, with voiceless affricates constituting the strongest consonants.

One important issue to be considered in the hierarchies is the quantification of sonority by assigning values to segments in different positions, the 'sonority indices' in

Selkirk's (1984, p. 112) words. Goldsmith (1990) remarks that by quantifying sonority it is possible to work with the notion of degree of distance to propose sequential constraints on the arrangement of segments in the form of absolute values. Selkirk (1984) and Laver (1994) also argue for the advantage of a quantification methodology. Selkirk calls attention to the fact that the characterization of the sonority hierarchy exclusively in relational terms would not be sufficient to account for sequences that, although consistent with the SSG, are disallowed, as is the case of nasal-liquid onsets in English. Comparing the onsets nasal-glide and nasal-liquid, she points out that at a relational level, both sequences fulfill the prerequisites of the SSG – sonority increases towards the nucleus – however, an arithmetic condition positing a minimum sonority difference[3] would be able to rule out the illegal sequence. Laver points out that a value-assignment system allows, not only the characterization of syllables internally by a sonority profile, but also the establishment of hierarchical relations at a cross-syllabic level. To a further extent, as Goldsmith (1990) proposes, if the method is correct, "then we may characterize languages with respect to how much sonority difference they demand of successive segments" (112).

A universal characterization of syllable structure based on strength relations is proposed by Hooper (1976) in the formula below, as the Syllable Structure Condition (SSC):

P (C) : $\$C_mC_nC_pC_qVC_rC_sC_t\$$

Where $m > n > p > q$

$r > s > t$ [sic][4]

$m > t$

$m \neq \emptyset$ (p. 229)

[3] Selkirk (1984) observes that Harris (1982) uses the term 'dissimilarity'. Other authors use 'distance'.
[4] As observed by Rebello (1997, p. 8) the arrows in this line should point in the opposite direction.

The author explains that the number of segments in the onset and coda positions is arbitrary and would vary in different languages. The SSG is implicit to the condition in an inverse way, since the condition is stated in strength, and the generalization in terms of sonority. The condition m ≠ Ø implies that the CV syllable must be allowed in any language. As to the condition m > t, it is important to observe the way Hooper means it to be read, that is, "the strongest C permitted in syllable-initial position must be stronger than the strongest C permitted [emphasis added] in syllable-final position" (p. 230). She observes that it should not be interpreted as postulating strength requirements in terms of the specific consonants occupying the slots, but rather, in terms of the syllabic positions per se. In this sense, in allophonic realizations, the strongest allophone will occur in syllable-initial position, whereas the weakest form will occur in final position. This hierarchical relation of syllabic positions is underpinned on the fact that phonological strengthening processes always occur in initial position, but never in final position, whereas weakening processes occur in final position. As strengthening processes occurring in syllable-initial position, Hooper (1976) presents the optional changes from glides into obstruents (fricatives) of Spanish words, such as in ***huevo*** [weβo] → [g^{w}eβo] or [ɤweβo] – 'egg'; *llamo* [jamo] → [ʒamo] or [dʒamo] – 'I call', and the aspiration of voiceless stops in English. Weakening processes that are bound to the final position are some types of assimilation, elision, lenition, degemination, etc (Istre, 1981).

According to Hooper, "violations of the universal SSC in particular languages are always the result of conflicting natural processes" (p. 232). These violations originate in diachronic change, and it is reasonable to claim that they tend to be corrected by changes in the direction of the fulfillment of that condition. This is the case for all processes that change syllable structure, such as vowel epenthesis.

This strength relation between syllabic positions gains particular interest when it is transposed to cross-syllabic contacts. Hooper says that

> as syllables are strung together, the end of one syllable (its weak position) immediately precedes the beginning of the next (the strong position) . . . . [and] it is reasonable to expect that the C in the stronger position will influence the C in the weaker position, but it is not reasonable to expect that the opposite relation will hold. (p. 200)

Then, the following formula is proposed to account for cross-syllabic contacts in Spanish:

> If $XVC_r\$C_mV$, and there is no pause between C_r and C_m, then $m > r$.
>
> (p. 220)

Clements (1990) cites Devine and Stephens (1977) and Christdas (1988) as applications of the principle to other languages where it was found to be valid as a general tendency "rather than an exceptionless law" (p. 286).

Hooper's (1976) condition is revised by Murray and Vennemann (1983), based on data of diachronic change, in three directions. First, the condition $m > r$ is modified to $m \geq r$ to incorporate the frequent occurrence of geminates in syllable boundaries; then, the notation $VC_r\$C_mV$ is changed to $C_r\$C_m$ to incorporate clusters longer than two-consonants; and finally, a reformulation in different terms is proposed that gives birth to "a general law for contiguous heterosyllabic marginal segments" – the Syllable Contact Law (SCL), as below:

> The preference for a syllabic structure $A^{\$}B$, where A and B are marginal segments and a and b are the Consonantal Strength values of A and B respectively, increases with the value of b minus a.
>
> Corollary: The tendency for a syllabic structure $A^{\$}B$ to change, where A and B are marginal segments and a and b are the Consonantal Strength values of A and B respectively, increases with the value of a minus b. (p. 520)

The probability of violations occurring in contiguous syllables is ranked in

relation to the preferred syllable pattern $a < b$. This preference relation is exemplified by the authors by the assignment of the values of Hooper's scale to the marginal segments of *am.la* (3, 2) and *at.i̯a* (6, 1) where the second sequence is said to be more likely to change than the first, owing to the greater difference in strength values between the segments in the marginal positions, which poses a stronger degree of violation to the preferred condition.

The diachronic change data that served as the basis for Murray and Vennemann 's reformulation of Hooper's condition consisted of remedial measures in the form of epenthesis, metathesis, and assimilation applied to violations to the condition occurring in Spanish. Other sources of historical change data presented are the processes of gemination, occurring in West Germanic, resyllabification with vowel lengthening in Old Icelandic and Faroese, and strengthening of glides in Gothic.

Baptista (1987) makes use of the SCL to describe resyllabification processes in connected speech of BP and Spanish. Contrasts between the two languages are exemplified by the differential realization of final consonants and the consequent differential syllabification processes. In the words *milagres* – 'miracles' and *mil acres* – 'a thousand acres' the first two syllables are indistinguishable in Spanish – [mi.la.ɡɾeS] and [mi.la.kɾeS]. In most dialects of BP, they are syllabified as [mi.ˈla.ɡɾeS] and [miu̯.ˈa.kɾeS]. In Spanish, resyllabification can be explained by the value of A being greater than that of B, that is, in violation with the SCL. In BP, the vocalization of the lateral brings it closer to the vowel and does not require resyllabification.

Baptista and Silva Filho (1997) and Rebello (1997) apply the SCL to synchronic data in the form of IL productions. As mentioned in the Introduction, the process of vowel epenthesis in the English of BP speakers was investigated in these studies as a function of the strength relation stipulated in the law, among other variables (see

Section 2.6). The present study is intended to add to Baptista and Silva Filho in investigating the potentiality of the SSC and SCL for explaining single-final consonant codas production in the English IL of BP speakers.

2.4 The American English syllable and the Brazilian Portuguese syllable

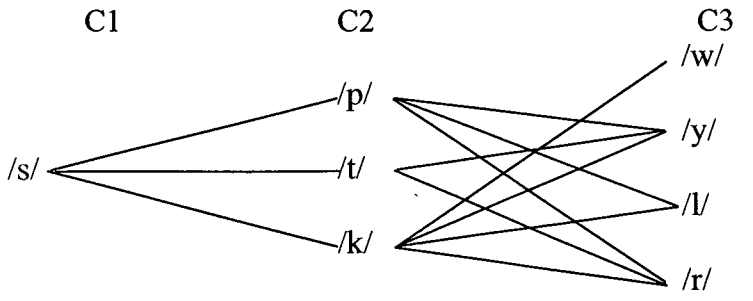
2.4.1 The American English syllable

According to Roca and Johnson (1999) the complexity of the English syllable makes it a useful resource for understanding syllables universally. This complexity is visible even in the simplified representation of the structure in Prator and Robinett (1985, p. 174):

(C)(C)(C)V(C)(C)(C)(C)

However, words with this structure are rarely realized with all four consonants in the coda. For example, the word *strengths* fills all slots in the underlying representation: /strɛŋkθs/, but is frequently pronounced as [strɛŋks].The word *button*, which has a vowel in each of its two syllables in the underlying representation, is often realized as [bʌtn̩], where a nasal consonant occupies the vowel slot. The formula shows that there are open and closed syllables in English, and that syllables vary in the number of elements permitted in the onset and coda, from zero to three elements in the onset, and from zero to four in the coda. The onsets are realized as follows (see Jensen, 1993; Kreidler, 1989; Prator & Robinett, 1985):

1) three-consonant onsets are limited to nine combinations, as Prator and Robinett depict in the schema:



(p. 176)

2) two-consonant onsets are formed by two major groups (see O'Connor, 1992): (a) If the first segment is /s/, then the second one must be /p, t, k, f, m, n, l, w, y/; (b) if the second segment is /l, r, w, or y[5]/, then the first one must be /p, t, k, b, d, g, f, θ, ʃ, v, m, n, h/; however, not all of these sequences occur. The full list of possibilities is

/p/, /b/, /f/ followed by /l, r, y/ as in *play, pray, pure, blue, bring, beauty, fly, fry, few*;

/t/, /d/ followed by /r, w, y/ as in *tree, twelve, Tuesday, dry, dwell* (rare), *dunes*;

/k/ followed by /l, r, w, y/ as in *clear, cry, quite, cure*;

/g/ followed by /l, r/ as in *glass, grass*;

/θ/ followed by /r, w/ as in *three, thwart* (rare);

/ʃ/ followed by /r/ as in *shrink*;

/v/ followed by /y/ as in *view*;

/m/ followed by /y/ as in *music*;

/n/ followed by /y/ as in *new;*

/h/ followed by /y/ as in *huge*.

[5] The glide /y/ after alveolars does not exist in AE. So, words like *dunes, Tuesday*, and *new* would be pronounced without the glide.

3) single-consonant onsets can be realized by any consonant. The only restrictions are for /ʒ/ (except for French borrowings: *genre*, *gendarme*) and /ŋ/ in word-initial syllables, and for /ŋ/ in medial stressed syllables.

The English coda is more complex than the onset, since it allows a greater variety of combinations. According to Jensen (1993, p. 70) four-consonant codas seem to be limited to cases of addition of an inflectional suffix to three-consonant codas, and some of these tend to be simplified by native speakers. Examples of four-consonant codas formed by the addition of the regular past tense inflection are ˈmpst as in *glimpsed*, and /ltst/ as in *waltzed;* and examples formed by the addition of the plural inflection are /ksts/ as in *texts*, /rsts/ as in *bursts*, and /lfθs/ as in *twelfths* (Prator & Robinett, 1985, p. 179). These last three tend to be simplified by native speakers in fluent speech to /kss/, /rss/, and /lfs/ or /lθs/. Four-consonant codas may also result from an epenthetic stop as in *strengths* /ŋkθs/, *danced* /ntst/, and *minced* /ntst/.

Many three-consonant codas appear with the addition of the inflectional suffixes of regular past tense and third person singular to verbs and with the addition of the plural inflection to nouns. Examples of the three cases are *learned* /rnd/, *works* /rks/, and *cards* /rds/. Other examples of three-consonant codas are /kst/ as in *text*, /mpt/ as in *prompt*, /ŋkt/ as in *distinct*, /mps/ as in *glimpse*, /nst/ as in *against*, /rps/ as in *corpse*, /rld/ as in *world*, /ksθ/ as in *sixth*, and /rpt/ as in *excerpt* (Jensen, 1993; Kreidler, 1989; Prator & Robinett, 1985).

The formation of two-consonant codas can be described based on Kreidler (1989) and Jensen (1993) as follows: (a) SS clusters (stop+stop) – /pt, kt, bd, gd/; (b) SF

clusters (stop+fricative) – /pθ, tθ, dθ, ps, ks, bz, dz, gz/[6]; (c) FS clusters (fricative+stop) – /sp, ft, θt, st, ʃt, vd, ðd, zd, ʒd, sk/; (d) FF clusters (fricative+fricative) – /fθ, fs, θs, vz, ðz/; (f) NC (nasal+C) – /mp, mt, mf, mz, nt, nd, ntʃ, ndʒ, nθ, ns, nf, nz, ŋd, ŋk, ŋθ, ŋz/; (g) -lC – where C can be /p, b, t, d, k, tʃ, dʒ, f, v, θ, s, z, ʃ, m, n/; and -rC clusters – where C can be /p, b, t, d, k, g, tʃ, dʒ, f, v, θ, s, z, ʃ, m, n, l/.

Single-consonant codas in American English may be realized by any consonantal segment except /h/.

2.4.2 The Brazilian Portuguese syllable

The syllabic system of BP is more restrictive than the English both in terms of number and of featural co-occurrences permitted at the syllable edges. Based on Cristófaro Silva's (1999) description of the syllabic patterns in BP, the simplified representation proposed for English by Prator and Robinett (1985, p. 174) can be tentatively depicted for BP both at the underlying and surface levels in the following way (where V' represents a glide segment):

(C)(C)V(V')(C)(C)

However, the two-coda consonants are realized phonetically in only a few words such as *perspicaz* [peRSpiˈkaS] – 'sagacious' as discussed below. The structure shows that there are open and closed syllables in BP, and that syllables vary in the number of

[6] Although pointed as one of the most common clusters by Prator and Robinett, /ts/ is not listed in Jensen and Kreidler. /md/ is also cited only by the first author.

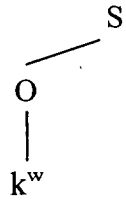
elements permitted in the onset, nucleus and coda, from zero to two elements in the onset and coda, and from one to two elements in the nucleus (a vowel or a vowel plus a glide, according to the discussion below). There is little consensus about this pattern, though. Controversial interpretations of the vocalic sequences that are common in Portuguese as in *suar* [ˈsu̯aR] or [suˈaR] – 'to sweat', and *juizado* [ʒu̯iˈzadʊ], [ʒuˌˈzadʊ], or [ʒuiˈzadʊ] – 'court' (Câmara Jr., 1970; Cristófaro Silva, 1999), and of the nasality feature, or of the status of /l/ in words such as *sol* [sɔu̯] or [sɔw] – 'sun', account for this lack of consensus.

Concerning the composition of the nucleus, there seems to be more consensus in considering the sequence /i/ or /u/+vowel as nuclei of two syllables than in assigning the glide in the vowel+glide sequence to the nucleus or to the coda position in the structure. Câmara Jr.'s (1970) interpretation of the /i/ or /u/+vowel sequence as in free variation is generally accepted by other authors (e.g., Bisol, 1989; Callou & Leite, 1990). There is free variation because the first element of the /i/ or /u/+vowel sequence can be pronounced as a glide or a vowel, that is, the sequence can be characterized as an on-glide diphthong or two vowels of contiguous syllables (e.g., *suar* [ˈsu̯aR] or [suˈaR] – 'to sweat', *criar* [ˈkɾi̯aR] or [kɾiˈaR] – 'to create').

Mateus and d'Andrade (2000) present the non-nasalization of the glides preceding nasal vowels as in *criança* [kɾiə̃ˈsɐ] – 'child', and *coentro* [kuˈẽtɾʊ] – 'coriander' (compare to (d) below) as an important argument in favor of the two-syllable interpretation of the sequence.

An interesting case frequently mentioned in the literature is that of sequences formed by [ʊa, ʊo, ʊi, ʊe] preceded by /k/ and /g/. Cristófaro Silva (1999) and

Collischonn (1999) make the point that these sequences are, in fact, formed by complex consonants (represented as /k^{w}/ and /g^{w}/) that behave as single consonants in the syllabic structure, followed by a vowel. In the tree diagram, these complex consonants are represented as:



(Collischonn, 1999, p. 112)

Examples of these sequences are the words *qual* [k^{w}aʊ̯] – 'which', *água* ['ag^{w}ɐ] – 'water', *aquoso* [ɐ'k^{w}ozʊ] – 'watery', *eqüino* [e'k^{w}inʊ] – 'equine', *agüenta* [a'g^{w}ẽtɐ] – 'sustains'[7]. These sequences, for which the reduction to glide rule is obligatory, remain from the Latin forms, but there seems to be a tendency to simplify the consonant to /k/, as there are alternative forms in some cases (e.g., *quo/cociente* [k^{w}o/ko] – 'quotient', *qua/catorze* [k^{w}a/ka] – 'fourteen').

The discussion concerning off-glides seems to involve less consensus than that of the on-glides, and the vowel+glide sequence may be viewed as VC or VV, that is, as a branching rhyme or a complex nucleus. Câmara Jr. (1953, cited in Cristófaro Silva, 1999, p. 169) advocated the VC interpretation. This view was shared by other structuralists, such as Barbosa (1965, cited in Mateus & d'Andrade, 2000, p. 39), who established that the glides should occupy the (C) slots preceding and following V in the structure. In this view, the word *quais* [k^{w}aɪ̯S] – 'which (pl.)' fills all slots in the CCVCC representation. The interpretation of the off-glide occupying the coda position

[7] [k^{w}i] and [g^{w}i/e] occur only written with the grapheme 'ü'. In *aquilo* [a'kilʊ] – 'that', *guerra* ['gɛRɐ] – 'war', and *águia* ['agɪɐ] – 'eagle', for example, 'u' is not pronounced.

is also maintained by Bisol (1989). The author considers that semi-vowels are high vowels in the underlying structure, which become glides in the syllabification process.

Câmara Jr. (1970) reviewed his 1953 interpretation of the vowel+glide sequence as VC, presenting arguments supporting that the glide must be seen as a modification of the nucleus. Similarly, Mateus and d'Andrade (2000) say that these sequences in Portuguese are traditionally called 'true diphthongs' and that a syllable carrying a true diphthong is characterized by a complex nucleus.

The following arguments are found in the literature in favor of the VV view (cf. Câmara Jr., 1970; Collischonn, 1999; Mateus and d'Andrade, 2000): (a) The [r] following VC syllables is the 'strong R' as in *Israel* [iʒRaˈɛʊ̯] – 'Israel', whereas the [r] following diphthongs is the 'weak r' as in *aurora* [aʊ̯ˈɾɔɾɐ] – 'dawn', and *amoreira* [ɐmoˈɾeɪ̯ɾɐ] – 'mulberry tree'[8]; (b) the glides in many diphthongs are deleted in colloquial language (e.g., *caixa* [ˈkaɪ̯ʃɐ] → [ˈkaʃɐ] – 'box', *dourado* [doʊ̯ˈɾadʊ] → [doɾadʊ] – 'golden'); (c) the glide /ɪ̯/ changes to /e/ in the vocative form of *papai/papaê*[9] [paˈpaɪ̯/paˈpae]– 'dad'; and (d) contrary to what happens in glide+vowel sequences, in vowel+glide sequences both elements are nasalized (e.g., *mãe* [mɐ̃ɪ̃] 'mother', *homem* – [omẽɪ̃] – 'man').

Returning to the proposed structure of the BP syllable, the onsets are realized according to the following restrictions:

1) Two-consonant onsets are restricted to the sequences in the chart (adapted from Schmidt, 1987, cited in Collischonn, 1999, p. 100):

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[8] The only exception seems to be the word bai[R]o – 'neighborhood', and its derived forms, but it must be noted that these are spelled with double 'r'.

[9] There are also the emphatic form of *sai – sae* [ˈsae] – 'get out' used by kids, and the surfers' greeting *daê* [daˈe], from *daí* [daˈi].

	Obstruent +/l/	Obstruent+ /ɾ/
Labial	pl, bl, fl, (vl)	pɾ, bɾ, fr, vɾ
Alveolar	tl	tɾ, dɾ
Velar	kl, gl	kɾ, gɾ

The underlined sequences do not appear in word-initial position, and are not very frequent in medial position. The sequence /vl/ occurs only in word-initial position and only in loan names as *Vladimir*, which are not very common in BP, and /dl/ does not occur in Portuguese.

2) Single-consonant onsets can be realized by any consonant in the BP inventory. The only exceptions are /ɲ/, /ʎ/, and /ɾ/ in word-initial position. The flap does not occur word-initially, and /ɲ/ and /ʎ/ are restricted to the loan words *nhoque* [ˈɲɔki] – 'gnochi', *lhama* [ˈʎãmɐ] – 'llama', *lhano* [ˈʎãnʊ] – 'plain', where they are very frequently pronounced with an initial [i], and to the third person indirect object pronouns *lhe* [ʎi] and *lhes* [ʎiS].

The syllable final consonants are restricted phonologically to /l/, /r/, /m/, /n/, /s/ and /z/, or, as Câmara Jr. (1970) proposes /l/, /r/, and the two archiphonemes /N/ and /S/.

There is a great deal of controversy concerning the final nasal, especially, since it involves what Mateus and d'Andrade (2000, p. 130) characterize as "one of the most challenging aspects of Portuguese", the process of nasalization.

There are two main interpretations of the process of nasalization in BP. The first is the view that a nasal element is specified in the production. The most discussed proposal, in this sense, is that of Câmara Jr. (1971), who argues in favor of the

archiphoneme /N/, which nasalizes the preceding vowel and assimilates to the obstruent in the following syllable, then is reduced as in *samba* [ˈsãᵐbɐ] – 'samba', and *lento* [ˈlẽⁿtʊ] – 'slow', maintaining only a nasal element. Cristófaro Silva (1999) says that the difference between a nasal segment [m] and a nasal element [ᵐ] is the shorter time spent in the articulation of the latter. In this view, the nasal vowels are represented phonologically as /iN/, /eN/, /aN/, /oN/, /uN/. Lopez (1979, cited in Monaretto, Quednau, & Hora, 1999, p. 200) rejects the archiphoneme view and considers nasalisation to be derived from an underlying /n/, specified as a coronal whose realization is conditioned by the following segment. Mateus and d'Andrade (2000) advocate that the process of nasalization occurs as the preceding vowel assimilates the nasal feature from an underlying nasal segment that is deleted at the phonetic level, so that *samba* and *lento* are realized as [sãbɐ] and [lẽtʊ].

The existence of this nasal segment at the underlying level is supported in the literature, basically, by the following arguments, among others (Mateus & d'Andrade, 2000; Battisti & Vieira, 1999): (a) The degemination that happens in sequences of oral vowels as in *casa azul* → *casazul* [kazaˈzuʊ̯] – 'blue house' does not happen in sequences of word-final nasal vowel + word-initial vowel (e.g., *lã azul* [lã azˈzuʊ̯] – 'blue wool'); (b) the pronunciation of the /r/ after a nasal vowel is always as the 'strong R', as it is pronounced after other closed syllables (e.g., *genro* [ˈʒẽRʊ] – 'son-in-law'), whereas the /r/ after a non-nasal vowel is the 'weak r' as in *gera* [ˈʒɛɾɐ] – 'he/she/it generates'; and (c) the phonetic realization of the prefix 'in' or 'im' when placed before a consonant is as a nasal vowel (e.g., *incapaz* [ĩkaˈpaS] – 'unable'), whereas when placed before a vowel it is realized as a vowel followed by a nasal consonant (e.g.,

inacabado [inakaˈbadʊ] – 'unfinished').

From the other point of view (Pontes, 1972; Back, 1973, both cited in Cristófaro Silva, 1999, p. 165), nasal vowel phonemes are opposed to the oral ones; thus, five nasal phonemes are added to the original seven vowels in the vocalic inventory of the language. Cagliari (1983, cited in Xavier, 1989, p. 52)) affirms that the front vowels are followed by a palatal nasal (e.g., *vim* [vĩɲ] – 'I came', vem [vẽɲ] – 'he/she/it comes'), the non-front vowels are followed by a velar nasal (e.g., *rum* [Rũŋ] – 'rum', *bom* [bõŋ] – 'good'), and [ə̃] allows both possibilities, or neither of the two (e.g., *irmã* [iRˈmãɲ], [iRˈmə̃ŋ], or [iRˈmə̃] – 'sister'). Cristófaro Silva (1999, p. 92) also ascribes the different realizations of the nasal in word-final position to the quality of the vowel involved. In her interpretation with 'a', 'o', 'u' – the nasal element does not occur (e.g., lã [ˈlə̃] – 'wool', tom [ˈtõ] – 'tone or pitch', atum [ɐˈtũ] – 'tuna'); however, with 'i' and 'e', both [ˈsĩ] and [ˈsĩɲ] are possible for *sim* – 'yes', and [ˈbẽɪ̯] and [ˈbẽɪ̯ɲ] for *bem* – 'well'.

This conditioning can also be determined by the following consonant, so that the words *samba* 'samba', *santa* 'saint', and *sanca* 'crown (or ceiling) molding' may be realized as [ˈsə̃mbɐ], [ˈsə̃ntɐ], and [ˈsə̃ŋkɐ], respectively.

Undoubtedly, the issue involves innumerable subtleties that have to be investigated with instrumental support, such as the case of the assumed conditioning of the nasal sound by the quality of the vowel or by the following consonant, or both. Furthermore, it is important to note that authors stress the role of dialectal variation in the realization of the nasal sound. As Baptista (1987) points out, "it is quite clear that [BP] native speakers are not much more comfortable with a nasal consonant in syllable-final position than they are with any other consonant" In fact, nasalization seems to be

an area where interesting insights from foreign language production could contribute to the understanding of a native language peculiarity (p. 6). Monahan (2001), for example, reports that in a study of word final consonant production, BP speakers applied to English final nasals the identical process of regressive assimilation of the nasality and subsequent deletion of the nasal consonant that is used in the native language.

The liquid /l/ occurs phonologically in both word-final and syllable-final position in BP (e.g., *sal* ['saʊ̯] – 'salt', *salgado* [saʊ̯'gadʊ] – 'salty'). Phonetically, it is in general vocalized. It may be realized as a velarized alveolar (or dental) lateral [ɬ], but this realization is rare, occurring mainly in the South of the country (Cristófaro Silva, 1999; Vandresen, 1999).

The vocalization is stable; it is not influenced by a following vowel or consonant (e.g., *mel escuro* ['mɛʊ̯iS'kurʊ] – 'dark honey', *mel claro* ['mɛʊ̯'klarʊ] – 'light honey'), and owing to this vocalization the adverb *mal* – 'badly' and the adjective *mau* – 'bad' are homophonous – ['maʊ̯] in BP. These facts seem to constitute reasonable justification for characterizing vowel+lateral sequences as vowel plus off-glide phonetically, and to propose that they may be interpreted as belonging to the complex nucleus at this level.

The final /S/ may be realized according to the following conditioning:

1) as [z] or [ʒ] depending on dialect, in word medial and final position, before voiced consonants (e.g., *desviar* [diz/ʒviaR]– 'to swerve', *três gatos* [trez/ʒ] [gatʊS] – 'three cats', *dez bois* [dɛz/ʒ] [boɪ̯S] – 'ten oxen').

2) as [s] or [ʃ] depending on dialect, in word medial and final position, before voiceless consonants (e.g., *desfiar* [dis/ʃfiaR] – 'to unthread', *três cães* [tres/ʃ] [kɐ̃ɪ̯S]

– 'three dogs', *dez* patos [dɛs/ʃ] [patʊS] – 'ten ducks').

The final /r/ is the 'strong R', which is realized as a fricative [x, ɣ], the retroflex [ɹ], or the trill [ř] (Cristófaro Silva, 1999; Vandresen, 1999). The 'weak r', the flap /ɾ/, also occurs in word final position, in all dialects, when followed by a word beginning with a vowel, as in *mar azul* [maɾazuu̯] – 'blue sea' and in some dialects as a variant of the 'strong R'.

The (C) slots in the coda structure of the BP syllable can be realized, then, taking into account the variation described above, as follows:

1) two-consonant codas occur exclusively in word-medial position, and are restricted to the occurrence of /S/, following /r/, /l/ and /n/. These sequences occur in words such as *perspicaz* [peRSpiˈkaS] – 'sagacious' and *perspectiva* [peRSpekiˈtivɐ] – 'perspective', in the non-vocalized pronunciation of /l/ in *solstício* [soɬSˈtisiu̯] (occurring in the South of Brazil) – 'solstice', and in the view that proposes the existence of a nasal segment/element in words such as *transporte* [tɾãNSˈpɔRti] – 'transportation'. The vocalization of /l/ into [u̯] in [sou̯Sˈtisiu̯] and the non-occurrence of a nasal segment/element in [tɾãSˈpɔRti] characterize the sequences, phonetically, as complex nucleus+single consonant coda, and simple nucleus+single consonant coda, respectively. Monahan (2001) remarks that the view that /l/ and /n/ do not surface is in perfect harmony with the OT perspective, which postulates that BP tends towards minimization of codas.

2) The realization of single final consonant codas is limited to [R], and the archiphoneme [S]. They occur equally at the word and syllable levels, as in the examples: (a) *lar* [ˈlaR] – 'home', *larva* [ˈlaRvɐ] – 'larva', and *paz, pás* [ˈpaS] – 'peace, shovels',

pasta [ˈpaStɐ] – 'briefcase'. Furthermore, /l/ is also possible in the velarized pronunciation in words such as *mal* [maɫ] – 'evil', and *malvada* [mɐɫvadɐ] – 'wicked' (fem.), and /N/ is considered in the view that proposes the existence of a nasal segment/element in words such as *lã* [ˈlaN] – 'wool', and lancha [ˈlaNʃɐ] – 'motor boat'.

There are a number of words in the BP lexicon, however, that contain sequences of consonants not conforming to the phonotactic restrictions described above. Based on Mateus and d'Andrade (2000, p. 42) the following list shows some of these clusters in BP:

Word-initial			**Word-medial**		**Word-final**	
Plosive+plosive						
[pt]			*captar*	'to		
[bt]			*obter*	'to obtain'		
[bd]			*abdomen*	'abdomen'		
[dk]			*adquirir*	'to		
[kt]			*pacto*	'pact'		
Plosive+fricative						
[ps]	*psicologia*	'psychology	*opção*	'option'	*fórceps*	'forceps'
[bs]			*absurdo*	'absurd'		
[bv]			*óbvio*	'obvious'		
[bʒ]			*objeto*	'object'		
[tz]			*quartzo*	'quartz'		
[dv]			*advertir*	'to advert'		
[ks]			*flexível*	'flexible'		
Plosive+nasal						
[pn]	*pneu*	'tire'				
[bn]			*abnegado*	'abnegate'		
[tm]	*tmese*	'tmesis'	*ritmo*	'rhythm'		
[tn]			*étnico*	'ethnic'		
[dm]			*admirar*	'to admire'		
[dn]			*adnominal*	'paronomastic'		
[gm]			*estigma*	'stigma'		
[gn]	*gnomo*	'gnome'	*benigno*	'benign'		
[kn]			*técnico*	'technician'		
Fricative+plosive						
[ft]			*afta*	'thrush'		
[mn]	*mnemónics*	'mnemonic'	*amnésia*	'amnesia'		

These words were introduced as loanwords through the written language from the 15th century on, and some of them have already undergone deletion of the first consonant as in *óptico* > *ótico* [ˈɔtikʊ] – 'optic', or vocalization of the consonant as in *lacte(m)* > *lâite* > *leite* [ˈlei̯ti] – 'milk'. However, some words did not undergo these modifications, making consonant clusters invariably classified as problematic in the literature.

A major differentiation in the evolution of EP and BP can be noted concerning these sequences. The phonetics of EP is completely comfortable with these sequences, and, in fact, tends to eliminate unstressed vowels in pre-tonic syllables, causing additional C clusters, as in *pessoa* [psoa] – 'person', *devedor* [dvdóɾ] – 'debtor'). In BP, sequences such as those in the above list are problematic and tend to be resyllabified by the process of vowel epenthesis so that *obter* [obˈteR] – 'to obtain' becomes [obiˈteR], and *psicologia* [psikoloˈʒɪa] – 'psychology' becomes [pisikoloˈʒɪa].

Through this process, the word *sob* /sob/ – 'under'[10], which is probably the only one in the language bearing a single final obstruent, differs from *sobre* [ˈsobɾi] – 'on' only by the presence of [ɾ] in the latter.

2.5 Epenthesis in Brazilian Portuguese

Over the years syllable parsing of Portuguese words carrying clusters such as the ones in the list has proven to be an exceptionally complex task. Although native

[10]*Sob* (particle in words such as *sobnegar*, *sobestar*) resulted from an artificiality of the language, to approximate the preposition *'so'* to the written form of Latin and EP (Câmara Jr., 1970/1999).

speakers do not have problems in parsing words such as *Vladimir*, which is the only example of the /vl/ sequence cited in the literature, or *atlas* ['atlaS] – 'atlas', or *livro* ['livɾʊ] – 'book', which contain infrequent sequences, words like the ones in the chart, even the common ones, are problematic (e.g., a.b*dicar* and a*b.dicar* [abidi'kaR] – 'to abdicate', *pa.cto* and *pac.to* ['pakitʊ] – 'pact'). M. Teixeira (personal communication, October, 25, 2001) reported that in a syllable parsing exercise conducted with a group of 53 students (approximate mean age=12 years), she computed for *ritmo* ['Ritimʊ] – 'rhythm', 24 occurrences of 'ri.tmo', 21 of 'rit.mo', and 8 of 'ri.ti.mo'. The solution found by the last group of students, when confronted with the complex sequence of consonants, was to make use in orthography, of a strategy well-established in the spoken language – the decomposition of the cluster into the basic syllable pattern of the language – CV.

As mentioned in the Introduction, this vowel insertion to break up unacceptable sequences of obstruents and also following disallowed final-consonants is a productive process in BP, attested by the addition of a vowel in the orthographic nativization of loanwords and in the conformity of acronyms to the CV pattern.

Câmara Jr. (1970) gives an interesting account of the different interpretations of the syllabic parsing of these 'problematic' words over the years. Traditionally, the first consonant of the cluster was judged to be a decreasing consonant ("consoante decrescente") and the syllable boundary inserted between the two consonants. He then cites his own earlier proposal (Câmara Jr., 1953) that the cluster formed an increasing consonantal group ("grupo consonantal crescente") with the preceding vowel as the nucleus of an open syllable. Finally, he proposes what he considers to be a more correct solution: the acknowledgment of the insertion of a vowel between the consonants,

justifying the phonemic status of this vowel by the following two facts that follow: First, words such as *rapto* [ˈRapitʊ] – 'kidnap' and *rápido* [ˈRapidʊ] – 'fast' are distinguished only by the voicing difference of the last consonants, because when the cluster occurs following a stressed vowel, the inserted vowel undergoes the same type of reduction of the post-tonic /i/ in words stressed on the antepenultimate syllable. Second, even when the cluster is before the stressed vowel, the reduction that the inserted vowel undergoes is weak and inconsistent. Common words such as *absurdo* [abiˈsuRdʊ] – 'absurd' are consciously pronounced with the vowel. In fact, in emphatic expressions, an additional stress is placed on the new syllable, as in *absolutamente!* [aˈbisuˈlutaˈmẽNti] – 'absolutely'.

Unlike what happens in other languages that also apply vowel epenthesis to loanwords and IL productions systematically, such as Japanese (Ross 1994), the quality of the vowel in BP productions does not present a wide variation. According to Kitto and Lacy (1999) there are two main types of epenthesis – copy epenthesis and default segmentism, which are two endpoints of a continuum and characterize both vowel and consonantal epenthesis. Examples of the two strategies in Kitto and Lacy are Selayarese, a Western Malayo-Polynesian language, which makes use of copy epenthesis as in /sahal/ [sahala] – 'profit', /potol/ [potolo] – 'pencil', /lamber/ [lambere] – 'long' (Mithun & Basri, 1985); Tongan, a Polynesian language, which employs default segmentism in loanwords as in [kenali] – 'colonel', [telefoni] – 'telephone', [kameli] – 'camel' (Kitto, 1997); and Ponapean, which uses an intermediate stage – the epenthetic vowel is [+high] or agrees with the features of nearby segments (Rehg & Sohl, 1981). In cases of copy, the epenthetic segment may share features with preceding or following elements, adjacent or not. Hooper (1976) states that in stress languages, the vowel inserted is by default the minimal vowel, and in many tone languages, and all

vowel harmony languages the vowel inserted copies from a neighboring vowel. English epenthesizes with the schwa [ə], the minimal vowel in the language in a few non-standard cases only (examples in Section 1.1).

In BP, the epenthetic vowel is, by default, the high front vowel /i/. Variation occurs only in the range of front vowels from /i/ to /e/. As Hooper explains, both /u/ and /i/ appear as reduced vowels in BP word-final position (e.g., solo ['sɔlʊ] – 'soil', late ['lati] – 'he, she, it barks'. However, she suggests that only the latter is employed as the epenthetic vowel, probably owing to the "added strength that the back vowel gets from the feature of roundness, which makes it stronger than the front vowel, leaving the front vowel as the weakest and thus the natural choice for the insertion rules" (p. 236). Hooper argues that this suggestion may find support in the fact that, as in BP, the weakest vowels in Japanese are also /i/ and /u/. However, in Japanese, both vowels act in IL epenthesis production (e.g., ***bureeki*** 'brake'), and /u/ is the most frequent, probably due to the little or no rounding of this vowel in the language. As Ross (1994) shows, other vowels appear in Japanese English IL epenthesis, probably conditioned by the neighboring vowels or consonants, or both (e.g., [donto] – 'don't', [kukku] – 'cook', [keiki] – 'cake', [ʃapingu] – 'shopping').

Variation in the epenthetic vowel in BP is mostly conditioned by dialectal peculiarities. In dialects that do not apply vowel reduction as a general rule, that is, where the final vowel in the word *leite* 'milk' is pronounced as [e], this characteristic is naturally transferred to vowel epenthesis. In this case, [e] is added to single final obstruents in acronyms and loanwords as the ones presented in Section 1.1, and may be used instead of [i] to break up the disallowed clusters (e.g., *acne* ['akene] – 'acne or

pimples'). It must be noted, however, that it seems to be a fact of the language that this dialectal non-reduction is systematic in single final consonants, but not in clusters. Besides, the non-reduced vowel may be avoided in these environments because in some words an emphatic pronunciation of the epenthetic vowel can be traditionally considered a marker of a less standard pronunciation. The word *pneu* – 'tire' is peculiar, in this sense. Different from the other words bearing consonant clusters, its standard pronunciation in BP is [peˈneʊ̯]. Dialectal variation works in the reverse direction, that is, by the reduction of the epenthetic vowel to /i/.

Owing to the tendency towards reduction, another possibility of variation is the devoicing of the epenthetic vowel. (B. O. Baptista, personal communication, May, 2000). Hooper (1976) and Major (1994b) point out the possibility of vowel deletion in casual speech. However, there are grounds for suspecting that the epenthetic vowel is never deleted in BP, but, in fact, only devoiced. A contrast between the sequences considered to be deletion in BP and EP realizations would certainly show a vocalic element in the former, but not in the latter.

Hooper says that when the epenthetic vowel is preceded by a palatal consonant, it is deleted in more casual speech (e.g., *ritmo* [ˈRitʃimʊ] (formal) → [ˈRitʃmʊ] (casual) – 'rhythm', and *étnico* [ˈɛtʃinikʊ] (formal) → [ˈɛtʃnikʊ] (casual) – 'ethnic').

However, palatalization of the alveolar stops preceding [i] is a dialectal phenomenon. One important point to account for is that, in general, speakers of that dialect tend to pronounce the affricate very fast, emphasizing the fricative portion of the segment in informal speech. It seems reasonable to suspect that what happens in informal speech with the palatalized consonants is not an isolated process of epenthesis suppression, but a more intricate modification that generally results in the prominence

of the preceding consonantal segment making the epenthetic vowel almost imperceptible. Since palatalization only occurs as a consequence of the epenthetic vowel, there must be no difference in the behavior of the palatalized (dialectal) and the non-palatalized pronunciation of the words above ([ˈRitimʊ], [ˈɛtinikʊ], [ɐdimiˈɾaR]) concerning this vowel. In both cases [i] seems to be present, as it is equally present with non-palatalizable segments such as in *técnico* [ˈtɛkinikʊ] – 'technician, coach', and *diagnóstico* [dɪagiˈnɔStikʊ] – 'diagnostic'. In the latter word, both the epenthetic and the non-epenthetic [i] seem to be present in all speech styles. In fact, stylistic variation in the production of consonant clusters in BP is expected to work towards the reduction of the epenthetic vowel in more formal speech, since, as said above, the emphatic pronunciation of this vowel may characterize less standard pronunciation.

Major (1994b) characterizes the pronunciation of word-final syllables formed by stop+[i]+/s/, such as in *lápis* [ˈlapS] – 'pencil', and *xerox* [ʃeˈɾɔkS] – 'xerox', also in casual speech, as 'devoicing or deletion' of unstressed [i]. He says that the reduction of these final sequences to consonant clusters in the L1 makes it "difficult to tell whether a Portuguese speaker of English who correctly produces a final CC sequence in English has 'acquired' it or is transferring it from Portuguese" (p. 665). It must be noted, however, that the transfer of the L1 cluster would allow for incorrect L2 productions as well, since because of dialectal variation in the final /s/ production, transfer would result in voiceless/voiced stop+[S] sequences as well. The acoustic (and presumably perceptual) saliency of /s/ is remarked by Selkirk (1984), among other authors. It is important to observe that the sequences characterized as deletion by Hooper (1976) and Major (1994b) involve the aspiration feature. Thus, it seems that the prominence of

aspiration makes the epenthetic vowel less perceptible in such sequences. Undoubtedly, acoustic analysis would be necessary to prove or disprove both claims, since the posited devoicing and deletion are based on informal observation.

Hooper depicts the multiplicity of the possibilities concerning the issue of vowel epenthesis in BP, concluding that "there are few absolutes; there is rather considerable variation in styles and tempos produced by a complex interplay of productive rules and conditions" (p. 116).

2.6 Epenthesis in the English IL of Brazilian Portuguese speakers

In the comparison of the English and BP syllabic systems, the striking differences in the complexity of the permissible structures of each system leads to the expectation that this may be an area of problems when the two languages establish contact. The more restrictive onsets and codas of BP bring it closer to the optimal universal CV syllable, disallowing a number of consonant clusters and single-consonant codas that are characteristic of the English language. As briefly described in the Introduction, the production of vowel epenthesis in the English interlanguage of BP speakers in these contexts has been attested in studies focusing on the problem from different approaches.

Tarone (1980/1987) investigated the production of consonant clusters and word-final consonants to identify syllable simplification strategies – vowel insertion, consonant deletion and glottal stop insertion. The study involved two speakers each of Korean, Cantonese and BP, narrating a story. The results showed that BP speakers made use of epenthesis frequently, whereas the other two pairs favored consonant deletion. Tarone concludes that the critical variable in the choice of strategies appeared to be the

speaker's language background; however, the preference for the CV structure seemed to operate regardless of transfer. Although Tarone's study yielded important results regarding the influence of the first language, some problems in her analysis of BP should be pointed out: The production of 'bag was' as [bægəwʌs], is compared to the native language sequence [gw] in the word *igual* [igwaw][11] – 'equal'. However, as Major (1987b) comments, the comparison is drawn between a syllable initial [gw] and a syllable final [g], without the necessary consideration of the effect of syllable position in terms of the phonotactics of the LI in question. In addition to Major's observation, the peculiarity of the [g^{w}] sequence in BP must be remembered (see Section 2.4.2). Finally, the production of 'place where' is compared to *sueño*, which is a Spanish word. In BP, the sequence [s̯ue] is possible within a word as in the proper name *Sueli*, but, it is not common. In this case the two-syllable realization is more common. Besides that, syllable position restrictions are being ignored in this case as well.

Major's (1986) study was the first of a series aiming at investigating the relationship of transfer and developmental processes in the acquisition of L2 phonology. In this study transfer and developmental processes were related to degree of foreign accent. Fifty-three BP L1 speakers with varying degrees of foreign accent in English (rated in a parallel procedure involving 10 native speakers), were recorded reading a word list, a sentence list and a text. Word-final vowel epenthesis production was investigated in terms of reflecting a transfer process when the vowel was realized as [i], or a developmental process when it was [ə]. This differentiation is explained by the fact that the first realization occurs in BP sequences (see Section 2.5), whereas the second

[11] The glide is transcribed as [w] here to make the comparison to the English target easier.

characterizes a step further in the direction of the target language, since it occurs in the L1 acquisition of English. Not surprisingly, considering the speakers' proficiency in English (intermediate and advanced), the rates of epenthesis were not high. However, both types of errors correlated significantly with global accent, and transfer errors were shown to decrease more rapidly than developmental ones. Results in terms of the different tasks showed that the frequency of epenthesis decreased significantly as the task became more formal (from text to sentence to word), a fact attributed to degrees of attention to speech. Directions for future research are given in terms of involving a wider range of proficiencies and speech styles in longitudinal studies.

Major (1987a, 1992, 1994b, 1996) reports on data, which sets out to test his Ontogeny Model of L2 phonological acquisition. The model proposes a chronology for transfer and developmental errors. Whereas transfer processes first predominate and then decrease over time, developmental processes are at first infrequent, then they increase and later decrease. Predictions are also made in terms of speech style. A second proposal of the model is that as style becomes more formal transfer decreases, whereas developmental errors increase and then decrease. In the last three studies the data on epenthesis production was pooled together with other types of transfer and developmental errors in BP. The 1987 study showed significantly differentiated production of final consonant clusters and single-final consonants according to L2 proficiency. Six beginning and six advanced speakers of L2 English were tested reading a word list, a sentence list ('normally and then 'as quickly as possible'), and a text. Beginning speakers showed a greater occurrence of both interference and developmental epenthesis. As in the 1986 study, the overall frequency of epenthesis tended to decrease as the style became more formal. The rates of epenthesis were higher for clusters than for single consonants in both groups, an outcome explained by the fact that in many

instances the single-final consonant was devoiced. According to Major, devoicing and epenthesis are in competition in this context. Differences concerning proficiency in the production of single-final consonants may be noticed in the two extreme styles (word list and text). The beginners favored devoicing in the most formal style and epenthesis in the least formal. The advanced group favored devoicing in both styles, since epenthesis production was practically eliminated from their production. Major analyses this differentiation in terms of the prevalence of developmental processes at the more advanced level, as postulated in the Ontogeny Model.

Fernandes (1996) investigated epenthesis production in word-initial single consonants and clusters and final single-consonants, involving thirty Brazilian students of English at intermediate and advanced levels. The data were elicited through text reading and interview. The results corroborate those of Major in terms of language proficiency and variation in the quality of the epenthetic vowel. The rates of epenthesis were higher for the intermediate students and from intermediate to advanced levels the frequency of [i] decreased, whereas [ə] increased. According to Fernandes, this variation in the quality of the vowel is due to an increased sensibility on the part of the advanced speakers to the L2 phonological system. In contrast to Major's studies, the more formal style induced more epenthesis production, although the difference in terms of style did not seem to be significant. Results in terms of type of target showed that epenthesis was favored by word-final labials, and word-initial dentals and alveolars, whereas /s/-clusters accounted for the great majority of the epenthetic cases.

Rebello (1997) investigated the production of epenthesis in word-initial /sC/ and /sCC/ clusters, based on markedness in terms of cluster length based on Anderson (1987), strength relations within the syllable based on Hooper (1976) and across syllables, that is, syllable contact based on Murray and Venneman (1983). Six Brazilian

students of English, two from each of three different levels ('false beginners', low intermediate and advanced) were recorded reading sentences. In these sentences, the target words beginning in an /sC/ or an /sCC/ cluster were preceded by silence, or by context words ending in a consonant or a vowel. Overall results showed that approximately 50% of the productions of these clusters included an epenthetic vowel (Table 1, p. 337) and her data are interesting because tendencies in opposition to theoretical propositions and to previous empirical studies were revealed concerning all variables investigated. As Rebello points out, her results were not submitted to statistical analysis; however, taken as they are they seem to point to a fruitful area of research. One interesting suggestion Rebello makes is to compare the production of epenthesis by Spanish and BP speakers, since most previous investigations of /s/-clusters dealt with the former.

Baptista and Silva Filho (1997) analyzed the occurrence of the epenthetic vowel in word-final single consonant codas. The study involved six Brazilian students of English at three levels of instruction (first, second and eighth semester). These students were recorded reading a list of 432 sentences, each containing a monosyllabic word ending in a single consonant (p, b, t, d, k, g, f, v, s, z, ʃ, tʃ, dʒ, m, n, ŋ) expected to cause epenthesis owing to the contrasts in the phonotactics of BP and English codas. Each of these consonants appeared in the context of 19 consonants, two glides, five vowels and silence, that is, at the end of the sentence (p, b, t, d, k, g, f, v, θ, ð, l, r, h, s, z, ʃ, tʃ, dʒ, m, n, w, y, ɛ, æ, ɑ, ɔ, oʊ). Four main areas of influence set the field for the study: (a) L1 transfer and universals of syllable structure based on Broselow (1983/ 1987a, 1984/1987b), Sato (1984/1987), Tarone (1980/1987), and Weinberger (1987), among others; (b) universal hierarchical relations involving markedness, based on

Eckman (1987a, 1987b, 1991), Eckman and Iverson (1994), Tropf (1987), and Yavas (1994, 1997); (c) phonological environment, in line with Carlisle's research (e.g., 1991a, 1991b, 1992, 1994); and (d) sonority relations across syllable boundaries, based on Hooper's (1976) Syllable Structure Condition (SSC), and Murray and Venneman's (1983) Syllable Contact Law (SCL). The overall rate of epenthesis was not high (13%), however, consistent tendencies in terms of each variable analyzed were detected.

Finally, Monahan (2001) is the first attempt to apply OT to BP syllable structure and to the production of English consonant clusters by BP speakers. The main objective of the study was to rank the constraints of BP syllable structure, from the perspective of OT, and determine if this ranking is transferred to L2. Five BP speakers with different L2 English proficiency levels were recorded reading the sentence 'I will say X again', where 'X' represents 67 words containing a target consonant cluster, at three different rates of speech – fast, normal and slow. Although regressive assimilation of nasality/nasal deletion and vocalization of /l/ were frequent in the productions, syllable simplification by vowel insertion was not. Monahan indicates two possible reasons for native-like productions of codas that one could expect to be epenthesized. First, word-initial and final clusters may be simply easier for BP speakers than final nasals and liquids, and second, because the targets were placed between vowels, the clusters could have been syllabified around these vowels. As to the first hypothesis, the fact that the speakers were not beginners might have accounted for the lack of difficulty with the clusters. The second hypothesis can be related to the outcomes of studies investigating different environments in terms of a vowel, a consonant, or a pause. One interesting fact about Monahan's data is the qualification of the epenthetic vowel as [ɛ] in initial clusters and [ə] in final clusters. The epenthetic vowel realized as [ɛ] certainly reveals dialectal transfer of the L1 into the

L2; and the absence of [i] may be taken as an indicator of the familiarity of the speakers with the target language, if the postulates of Major's Ontogeny Model are right, which would thus help to explain why epenthesis was not frequent. Monahan concludes that owing to the strong evidence provided by the other two processes, it can be claimed that the L1 ranking of constraints is transferred into the L2.

2.7 Conclusion

The difficulty in achieving a consistent definition of the syllable has permeated the debate on the role of the syllable as a unit of speech perception and production. Definitions as those in Roca and Johnson (1999): "a syllable is a cluster of sonority defined by a sonority peak" (p. 248) and "syllables are mountains of sonority" (p. 638), may seem straightforward; however, because they are underpinned on the sonority principle, they turn out to involve a long and intense debate. The concept of sonority is by itself a complex matter largely discussed in the literature. On the one hand, authors stress the lack of agreement about the phonetic parameters on which to base the definition of sonority. On the other hand, there is also the lack of phonological information about the precise nature of the sonority hierarchy. Clements (1990) depicts the complexity of the debate, saying that "phoneticians and phonologists have characteristically taken different approaches to answering [the question of] an adequate account of what 'sonority' is" (p. 284). He comments that, as pointed out by Selkirk (1984), the requisite for the definition of the phonetic character of sonority is for phonologists to reach an agreement about the identity of the sonority hierarchy, which would help to account for the diversity of hierarchies proposed in the literature. The debate seems to lead to circularity in that the

necessity of a clear definition of sonority in phonetic terms is pointed out as a condition for the phonological characterization of sonority hierarchies, and, at the same time, it is asserted that only by the establishment of the linguistic definition of the hierarchy can the phonetic parameter(s) of sonority be stipulated.

Adding further complexity to this debate, there are discussions about the existence of a universal sonority hierarchy, and of a universal syllable-boundary insertion rule. Proposals such as Hooper's (1972, 1976), built on a universal basis, admit the inclusion of rules accounting for language-specific facts. Language-specific restrictions concerning syllabification occur both in terms of the quality and quantity of constituents of each syllable position in the structure. For this reason, the investigation of L2 pronunciation difficulties in the realization of syllable boundaries has to take into account the specificities of the L1 syllabic system as a fundamental source of problems.

This chapter made clear that Brazilian Portuguese and English differ widely in terms of the syllabic structures allowed. In particular, the description of the codas in this chapter shows that there are crucial differences in the two languages and, that the absence of obstruents in the coda position in the Brazilian Portuguese system may account for the difficulties the speakers of this language demonstrate when dealing with that pattern in English.

In general, BP speakers tend to make syllable-final obstruents pronounceable via the insertion of a vowel after them, bringing the sequence to the CV pattern characteristic of the L1. The resistance of BP speakers to dealing with sequences of obstruents within words and with single-final obstruents is apparent in the way these forms are dealt with when they occur in the native language itself. These occur in very specific cases, namely in a few words that exist in the BP lexicon (see a list in Section 2.4.2), and in acronyms and loanwords. Vowel epenthesis is the productive process

applied by BP speakers in both cases.

BP and EP show inverse tendencies in this sense: whereas EP is completely comfortable with sequences of obstruents, and, in fact, favors the omission of unstressed vowels in some pre-stressed syllables, BP tends not only to insert a vowel there, but also to stress it in emphatic utterances. Although neither the vowel insertion nor its stressing is encouraged in the more formal registers of the language, these processes are definitely part of the native speakers' everyday usage.

English final obstruents or sequences of obstruents within words or at word boundaries in contact seem to undergo the same kind of pronunciation strategy. By inserting a vowel, the L2 structure is simplified, that is, brought to a pattern in conformity with that of the native language, and thus, made more pronounceable.

This chapter consisted of a general overview of the debate on the definition of the syllable in phonological theory, and of a description of the syllabic structures of BP and English, the L1 and L2 involved in the investigation of vowel epenthesis perception and production. Following Baptista and Silva Filho (1997) on which the present study was based, focus was given to the theoretical framework proposed by Hooper (1976) and Murray and Vennemann (1983) to define the syllable and the conditions for syllabic contact that are applied in the analysis of the data gathered.

The description of the syllabic structures of the languages in contact is essential to inform the discussion of the role of the internal linguistic constraints investigated in the experiment reported here – universal markedness relations, and phonological environment – and of the relationship between perception and production – the external linguistic constraint investigated (see Chapter 4). The description also makes it possible to examine the interaction acknowledged by Baptista and Silva Filho of L1 transfer with the constraints above.

CHAPTER 3

UNIVERSAL MARKEDNESS RELATIONS AND PHONOLOGICAL ENVIRONMENT

3.1 Introduction

The purpose of this chapter is to present an overview of phonological research on markedness relationships and phonological environment in the area of L2 syllable structure production.

This overview focuses on the main aspects of a representative body of empirical research that contributed to building the framework of the present dissertation both in terms of design and outcomes. In the first part of the chapter, markedness theory is described in broad terms, and the theoretical foundations for hypotheses in phonological research concerning markedness relations are described. Then, a number of studies investigating markedness relationships in L2 syllable structure acquisition are reviewed, grouped according to five variables which seem to have elicited fruitful research data, despite their recentness: (a) consonant cluster reduction as a function of L2 syllable simplification towards the universal CV pattern; (b) relative markedness of consonant clusters; (c) the role of voicing in the production of L2 single-final consonants; (d) the effect of place of articulation on this production; and (e) the effect of sonority relations among final consonants in general and within the class of obstruents in particular..

In the second part of the chapter, phonological environment is defined and a brief historical account is given of the evolution of research focusing on the linguistic environment as a variable affecting phonological production. Then, research investigating

the effect of the phonological environment on L2 syllable structure production is reviewed. Two variables of environment are described, following Baptista and Silva Filho (1997): (a) the influence of a consonant, a vowel, or a pause as the linguistic context of target onsets or codas, and (b) the effect of sonority relations across syllables.

Owing to the fact that Baptista and Silva Filho and, to a certain extent, Rebello (1997) are the two studies most directly related to this dissertation, special attention is given to these studies in the reviews.

3.2 Markedness relations in IL phonology

Although the concept is older, the term 'markedness', as it has been applied to linguistic theory and research in the last decades, was introduced by the European linguists of the Prague School in the 1930s. Markedness theory postulates that "in the languages of the world certain linguistic elements are more basic, natural, and frequent (unmarked) than others which are referred to as 'marked'" (Richards, Platt & Platt, 1992, p. 220). As mentioned in the Introduction Section of this dissertation, the application of markedness theory to phonological studies has been particularly productive in the area of L2 syllable structure acquisition.

3.2.1 The Markedness Differential Hypothesis and the Structural Conformity Hypothesis

The tendency to apply markedness theory to phonological research stemmed from

Eckman's (1977/1987a) proposal of the Markedness Differential Hypothesis (MDH), formulated as an attempt to account for major drawbacks in the Contrastive Analysis Hypothesis (CAH), which for 20 years or so had been the most influential paradigm for L2 acquisition. The CAH (Lado, 1957; see historical overviews in Ellis, 1986; Gass & Selinker, 1994) is based on the assumption that by contrasting the L1 and L2 systems and identifying the differences, it is possible to predict the areas of difficulty in the L2 acquisition:

> Those structures that are similar will be easier to learn because they will be transferred and may function satisfactorily in the foreign language. Those structures that are different will be difficult because when transferred they will not function satisfactorily in the foreign language and will therefore have to be changed. (Lado, 1957, p. 59, cited in Gass & Selinker, 1994, p. 60)

The CAH began to lose prestige with the advent of generative grammar in the early 1970s, which rejected the structuralist view of a language as a set of habits, and with a growing body of research reporting counterevidence to the predictions of the hypothesis (e.g., Dulay & Burt, 1973, 1974a, both cited in Ellis, 1986, p. 28; Duškova, 1969; Richards, 1971; Sciarone, 1970, all cited in Eckman, 1996, p. 196). In Broselow's (1983/1987a) words

> Disenchantment with . . . the contrastive analysis hypothesis stemmed in part from the fact that while researchers could often predict which aspects of the second language would present problems for language learners of a particular first language background, it was often impossible to predict what the language learners would do to resolve these problems. (p.292)

Eckman (1977/1987a) makes the point that the inadequacy of the CAH lies in the fact that it does not account for directionality of difficulty. Taking two L1s X and Y, differing in a given feature, the CAH would simply identify a certain difference and predict difficulty for acquisition of the feature by L2 learners. No prediction would be

made considering the hypothesis that the speaker of X could have more difficulty in learning/acquiring Y, or the reverse. He examines this relationship applying the CAH to voiced and voiceless obstruents of German and English. Voiced obstruents are more marked than voiceless obstruents. There are no languages in the world with just voiced obstruents, thus, the presence of these consonants implies the presence of voiceless obstruents. English has both voiced and voiceless obstruents at word-initial, -medial and -final levels, whereas German has the contrast only at word-initial and -medial levels. In word-final position, it has only voiceless (the less marked) obstruents. The CAH alone predicts difficulty equally for German speakers acquiring the final contrast in English, and for the English speakers acquiring the lack of contrast in German, although the latter prediction has been shown to be untrue (Moulton, 1962, cited in Eckman, 1987a, p. 57).

In order to account for this major drawback of the CAH, Eckman (1977/1987a) proposes the Markedness Differential Hypothesis (MDH). The author argues that the L1-L2 comparison is necessary, as the CAH proposes, but it is not sufficient, and a notion of 'relative degree of difficulty' – universal and independent of L2 acquisition specifics – must be incorporated into the CAH to account for the directionality of difficulty. There are two fundamental notions for the development of the MDH: first, the notion of typological markedness (typologically marked features and phenomena are ranked according to degrees of difficulty); and second, the notion of implicational markedness:

> A phenomenon A in some language is more marked than B if the presence of A in a language implies the presence of B; but the presence of B does *not* imply the presence of A. (Eckman, 1987a, p. 60)

The MDH states that

> the areas of difficulty that a language learner will have can be predicted on the basis of a systematic comparison of the grammars of the native language, the target language, and the markedness relations stated in universal grammar such that,
> (a) Those areas of the target language which differ from the native language and are more marked than the native language will be difficult.
> (b) The relative degree of difficulty of the areas of the target language which are more marked than the native language will correspond to the relative degree of markedness.
> (c) Those areas of the target language which are different from the native language, but are not more marked than the native language will not be difficult. (p. 61)

Eckman (1996) explains that because the MDH was "*too* programmatic with the CAH" it failed to account for situations where difficulty occurs in areas where the L1 and the L2 do not differ. To account for this drawback, the author proposed the Structural Conformity Hypothesis (SCH) (Eckman, 1984, 1991; Eckman, Moravcsik, & Wirth, 1989). This hypothesis does not consider differences between the L1 and the L2 systems and simply states that "the universal generalizations that hold for the primary languages hold also for interlanguages" (Eckman, 1991, p. 24). The SCH is underpinned on two axes: (a) on Selinker's (1972) IL hypothesis, and Adjemian's (1976) claim that ILs are linguistic systems, that is, languages in their own right; and (b) on the belief that the universal generalizations are equally universal concerning primary and nonprimary languages. The importance of the SCH, in this sense, is that it deals with the "open and empirical question whether IL structures conform to the same universal constraints as do the structures of L1s" (Eckman, 1996, p. 205). Eckman (1991) tested the SCH phonologically. The generalizations tested were two implicational universals concerning initial and final consonant clusters formulated by Greenberg (1978, cited in Eckman, 1991, p. 24) :

a. Fricative-Stop Principle: if a language has at least one final consonant sequence consisting of stop + stop, it also has at least one final sequence consisting of fricative + stop.
b. Resolvability Principle: if a language has a consonantal sequence of length *m* in either initial or final position, it also has at least one continuous subsequence of length *m*-1 in this same position.

The potentiality of the SCH was tested with data from the L2 English of Korean, Japanese and Chinese (Cantonese) speakers producing word-initial and word-final clusters. None of the L1s allow these clusters. The results showed a high rate of instantiations (97.5%) obeying the generalizations above, providing support for the SCH. Relating the SCH and the MDH, Baptista and Silva Filho (1997) explain that the predictions concerning the German-speaking learner of English would be similar in the scope of the two hypotheses, but the SCH would not necessarily predict difficulty. The SCH accounts for the fact that there might be German-speaking learners of English whose IL contains voiceless but not voiced obstruents in final position (non-nativelike) as there might be those whose IL contains both voiced and voiceless obstruents in final position (native-like); however, it is not likely that we find a learner whose IL includes voiced but not voiceless obstruents in this position. The predictions concerning the English-speaking L2 German learner, are similar: we may find some speakers whose IL presents only voiceless obstruents (native-like) and some whose IL presents both voiced and voiceless obstruents (non-native-like), but it is not likely that we find speakers whose IL presents only voiced obstruents in word-final position.

Eckman (1991) declares that the SCH is both theoretically and empirically superior to the MDH. Theoretically, it is stronger since its testing against other competing hypotheses shows superior falsifiability. All of the facts that support the MDH will also support the SCH, however not all facts that support the SCH will support the MDH. It is empirically superior in that it allows for broader testing possibilities since it does not limit its predictions to situations where the L1 and the L2 are different. In this sense, Eckman (1996) claims that progress has been made from the CAH to the MDH, and then to the SCH, since from the former to the latter each hypothesis has been replaced by a stronger hypothesis, that is, a more falsifiable one. He

concludes that the CAH and the MDH have in common the prediction of difficulty, and are differentiated by the incorporation of markedness into this prediction, and that the MDH and the SCH have in common the use of markedness relations, and are differentiated by the elimination of L1-L2 differences as a requisite for predictions of difficulties in language learning/acquisition.

3.2.2 Markedness relations in L2 syllable structure

A number of researchers have investigated markedness relations in IL syllable structure acquisition. As Baptista and Silva Filho (1997) remark, the first studies in the area were mainly concerned with the investigation of consonant cluster reduction as a function of syllable simplification towards the universal CV pattern (e.g., Anderson, 1987; Broselow, 1983/1987a, 1984/1987b; Carlisle, 1988, 1991a, 1991b; Karimi, 1987; Sato, 1984/1987; Tarone, 1980/1987; Weinberger, 1987). In general, results of these studies indicate that LI transfer competes or interacts with the universal preference for the least marked syllable type – the CV syllable – in the production of L2 onsets and codas. The prevalence of transfer errors in the data examined by Broselow (1983/1987a) leads her to conclude that "errors which are systematic but are not attributable to transfer from the first language . . . may perhaps arise in just those cases in which the target language forms violate certain universal principles" (p. 302). In Broselow (1984/1987b) she claims that the discussion of the susceptibility of syllable rules to L1 transfer has to be taken in a broader perspective, within the investigation of the types of phenomena that participate in the process of transfer, and proposes

> as a preliminary hypothesis that those aspects of a phonology which are generally considered 'surface', 'low-level', or 'phonetic' rules and constraints are those which are most likely to be transferred to the target language. The class of 'low-level' phenomena include phonotactic constraints . . . and allophonic rules. (p. 276)

Another body of studies has focused on the relative markedness of consonant clusters (e.g., Abrahamsson, 1999; Anderson, 1987; Carlisle, 1988, 1991b, 1992, 1997, 2001; Eckman, 1987b, 1991; Eckman & Iverson, 1993; Hancin-Bhatt, 1997, 2000; Rebello, 1997; Sekiya & Jo, 1997; Tropf, 1987; Weinberger, 1987). With the exception of Rebello's study, the results of these studies indicate that markedness related to cluster length operates independent of L1 transfer – longer clusters are more frequently modified than shorter ones. Rebello found an opposite pattern in the results calculated for cluster length alone, although the difference in the rates of epenthesis for /sC/ and /sCC/ clusters was very small (59% and 55%, respectively). Analysis of these clusters grouped according to their second component showed a balance in terms of production of epenthesis before /sC / and /sCC/, but the difference was also very small. Regarding cluster composition, the results of this study showed that BP speakers produced more epenthesis before /s/-nasal and /s/-liquid – clusters not in violation of the Syllable Structure Generalization (SSG) – than before /s/-stop – clusters in violation of the generalization. The author comments that the decisive factor for these results was the voicing assimilation occurring in the non-violating clusters, which seems to have contributed to triggering epenthesis in these clusters. Major (1996) also found that the English /sl/ onsets produced by beginning BP speakers were more frequently epenthesized than the /sp, sk, st/ onsets. Like Rebello, Major observes that this assimilation is typical of BP, characterizing L1 transfer. Furthermore, Rebello acknowledges that the effects of assimilation were strong both within and across-syllables. Rebello calls attention to the fact that due to voicing assimilation, the /s/-nasal

and /s/-liquid clusters may become more marked than the /s/-stop and in view of this, the results of epenthesis production do not go against markedness theory. She makes this suggestion based on Greenberg's (1965, cited in Carlisle, 1994) generalization that voiceless obstruents are less marked than voiced obstruents in obstruent+obstruent and obstruent+sonant clusters. Both Rebello (1997) and Carlisle (1992) found that /s/-nasal clusters elicited more epenthesis than /s/-liquid, results in accordance with the SSG.

A third group of studies examining markedness relations in IL syllable structure acquisition has focused on the rolé of voicing in L2 single-final consonants (e.g., Baptista & Silva Filho, 1997; Eckman, 1981; Edge, 1991; Flege & Davidian, 1984; Flege, McCutcheon & Smith, 1987; Major & Faudree, 1996; Sekiya & Jo, 1997; Wang, 1995). In general, these studies have shown that (a) final consonant devoicing is largely used by speakers of L1s which do not have the voicing contrast, independent of the presence of a devoicing rule in the L1, and even if the contrast exists in initial position, and (b) epenthesis and deletion appear as syllable simplification strategies occurring largely under the influence of L1 transfer. In three of the studies above the investigation of the role of voicing in triggering final consonant coda modification has points in common with the experiment carried out in the present dissertation. Firstly, Wang (1995), investigated the production of 10 Mandarin speakers of L2 English. As BP, Mandarin lacks obstruents in coda position, allowing only the glides and two nasals (/n/, /ŋ/).The results of the study showed that the total error rate for voiced stops was greater than for voiceless stops; however, concerning epenthesis there was no difference between these rates (both 36%). Devoicing was responsible for 19% of the errors in voiced productions, and the rates of epenthesis and deletion were similar. Broselow, Cheng and Wang's (1998) analysis of Wang's data emphasizes that there was a visible preference for epenthesis

over deletion in the production of monosyllables (the syllabic pattern investigated in this dissertation) making them bisyllabic, whereas deletion was preferred in the bisyllabic inputs. The preference for one or the other syllable simplification strategy is explained by the authors from the perspective of OT, which posits that the tendency towards bisyllabic forms comprises a "cumulative effect of several constraints requiring that each major lexical category word . . . contain a stress foot, that the feet be binary, and that all syllables be parsed into feet" (p. 271). The bisyllabic form is considered optimal since it allows every syllable to be parsed into a binary foot.

The second study investigating the influence of voicing on syllable-final consonant production, Sekiya & Jo (1997), investigated the production of 40 Japanese, intermediate students of English. Also as BP, Japanese lacks obstruents in coda position, and as BP learners of L2 English, beginning Japanese students "are known to use epenthesis after both voiceless and voiced consonants" (p. 295), whereas consonant deletion is not common. As expected, there was no deletion, whereas for voiced stops the rates of epenthesis and devoicing were similar. As in the previous study, the total error rate for voiced stops in Sekiya and Jo's study was greater than for voiceless stops, and concerning epenthesis production, this difference was statistically significant.

The third study that has points in common with the present one in the investigation of the influence of voicing on final consonant modification is, obviously, Baptista and Silva Filho (1997). As described before (Section 2.6), the data in this study comprised only monosyllabic forms, and BP phonotactics is very restrictive in coda position (see Section 2.4.2). Whereas in the former studies some devoicing or deletion, or both, were present, in this study none of such productions was reported. The rates of epenthesis for voiced obstruents were higher than for their voiceless counterparts in four of the six pairs analyzed, and in the other two pairs the rates were identical. The authors

related the occurrence of the identical rates in labial obstruents (/f/, /v/, and /p/, /b/) to Yavas's (1997) finding that bilabials were the least devoiced of the stops. Yavas investigated the influence of place of articulation on the L2 English of Mandarin, Japanese and Portuguese speakers, based on speech aerodynamics data from L1 and L2 studies. The results showed that as predicted, final stops presented more devoicing as the place of articulation progressively moved back (bilabials presented less devoicing than alveolars, which in turn presented less devoicing than velars). Baptista and Silva Filho (1997) propose that

> if bilabials are the least frequently devoiced of the stops, then this is because the greater supraglottal area makes them not much more difficult to pronounce in final position than their voiceless counterparts. Thus, not only would labial obstruents be less frequently devoiced than other voiced obstruents by speakers who use the devoicing strategy, but there would be no more need for vowel epenthesis for these than there would be for the voiced member of each pair. (p. 29)

The effect of place of articulation was further studied in Baptista and Silva Filho, based on Yavas's (1997) claim. The rates of epenthesis for stops, in general, increased as the place of articulation progressively moved back (bilabials – 10.5%, alveolars – 13.5%, velars – 17%). This tendency was found to be greater in voiced stops (10.5% for bilabials, 16.7% for alveolars, 21% for velars), whereas among voiceless stops the rates of epenthesis did not differ much (10.5% for bilabials, 10.3% for alveolars, 13% for velars). The results of Sekiya & Jo (1997) also corroborated those of Yavas, since the velar consonant was significantly more often devoiced than the alveolar one (the bilabial was not investigated for lack of sufficient tokens).

Overall, research on the role of voicing in L2 single-final consonant productions indicates that universal markedness relations in terms of voicing distinctions are at play in triggering errors – the more marked voiced obstruents have been shown to cause

more difficulties than their less marked voiceless counterparts. However, LI transfer interacts with markedness determining the types of strategies chosen by different language groups to modify syllable structure, as shown in the three studies reviewed above.

The influence of markedness in L2 syllable structure modification has also been studied in terms of sonority relations. Three studies, in particular, have investigated this issue (Tropf, 1987; Eckman & Iverson, 1994; Baptista & Silva Filho, 1997).

Eckman and Iverson claim that in syllable final position, obstruents are typologically marked relative to sonorants. This typology is explained in that (a) many languages of the world disallow obstruents in syllable final position; (b) other languages allow some obstruents; (c) a third type completely disallows consonants; but (d) no language allows only obstruents in this position.

Tropf found that, as predicted, phonological error correlated positively with markedness and negatively with degree of sonority in the study of Spanish speakers producing L2 German single-final consonants. Final consonant deletion decreased with sonority values increasing from plosives, to fricatives, then nasals, and finally, laterals. Eckman and Iverson's (1994) data from Japanese, Korean and Cantonese speakers of L2 English also showed that, as predicted, obstruents were more difficult than nasals. However, contrary to predictions, liquids were shown to be more difficult than nasals, a fact attributed to L1 transfer. In Baptista and Silva Filho's (1997) study the rate of epenthesis for obstruents was more than three times higher than that for nasals. As in the previous study, transfer seemed to be an important factor in this study, since the rate for nasal assimilation/deletion, that is, the realization of the nasal as in the L1, was higher than that for epenthesis. The liquids were not investigated in their study.

A close observation of Baptista and Silva Filho's elicitation material may open an interesting question regarding the realization of nasals: because the target words for /m/ and /n/ were orthographically represented as both 'm' and 'me', and as 'n' and 'ne' respectively, it seems reasonable to speculate that orthography played a role in the production of epenthesis after these consonants. Whereas it is very likely that BP speakers epenthesize 'time goes' and 'Jane practiced', it is not expected that 'Tom goes' and 'Ben practiced' be epenthesized, but rather, that they undergo the same assimilation/deletion process characteristic of the L1 final nasals (see Section 2.4.2). Another interesting question concerning the nasals is related to the production of /ŋ/. Informal observation leads to speculation that there is a tendency for BP speakers to realize this consonant as an L1 nasal followed by [g], frequently adding vowel epenthesis. Therefore, in this case, epenthesis is not triggered by the nasal, but by the voiced velar stop.

Baptista and Silva Filho (1997) also examined Eckman and Iverson's (1994) claim that among the obstruents, the most marked in final position are the affricates, followed by fricatives, and then by stops. The German neutralization of voiced obstruents to voiceless ones in syllable final position studied by Goldsmith (1990) and the Korean neutralizations of fricatives and affricates to stops studied by Kim-Renaud (1978) are cited as instances of the tendency towards the "unmarked articulation of codas" (p. 255).

However, as Baptista and Silva Filho remark, the authors do not test their statement of markedness relations within obstruents, which contradicts Hooper (1976), Selkirk (1984), and others who state that the stronger (less sonorant) the consonant, the more marked in coda position. Baptista and Silva Filho set out to test the claim and found conforming results. Affricates triggered more epenthesis (20.4%) than fricatives (14.9%), which in turn presented more word-final epenthesis than stops (13.5%). This

tendency was also found in the more marked voiced obstruents, where affricates presented the highest rate of epenthesis of all consonants (29.6%). In the less marked voiceless obstruents, fricatives presented more epenthesis, followed by stops, and then affricates, although the differences in these rates were very small.

The same types of consideration made above for the nasals must be raised for the alveolar fricatives (/s/, /z/). The rate of epenthesis for this class was lower than that for all other classes, except for the bilabial stops. As the authors explain, this low rate may be naturally related to the fact that these consonants are phonetically realized in syllable final position in BP. This is also the case of the alveopalatal fricative (/ʃ/), and the rates of epenthesis for all three consonants were some of the lowest (11.4% for the alveolar fricatives and 10.5% for the palatal). Observation of the data suggests that the influence of orthography may have followed the same trend speculated for the nasals. The data include both 's' and 'se', and 'z' and 'ze' spellings. This speculation seems particularly valid considering that the rate of epenthesis for /z/ alone was 16.7%, compared to 6.2% for /s/, and that 89% of the words with /z/ presented the 'ze' spelling, and 42% of the /s/ words were 'se'. In sequences such as 'haze got' and 'Liz got', or 'voice became' and 'dress became', it is very likely that BP speakers epenthesize the first sequence of each pair, but not the second. As to the production of /ʃ/, the fact that it is a dialectal alternative to final /s/ in BP may have contributed to the low rate of epenthesis. These speculations are drawn on informal observation of L2 English of BP productions and are research challenges to be tested in careful empirical investigations, specially considering the wide dialectal variation of final sibilants and the unresolved characterization of the nasal feature in BP. As mentioned before, in Tropf's (1987) study stops were more frequently omitted than fricatives; thus, the two studies investigating the relation claimed by Eckman and Iverson

(1994) in terms of the markedness relations between the two classes yielded results pointing in opposite directions.

3.3 Phonological environment

Wolfram and Johnson (1982) remark that "there is a universal principle that applies to all sound systems, namely, that sound units tend to be influenced by their environments" (p. 88). Phonological environment or context is the frame in which a sound occurs, and its influence on shaping production can be attested in a number of phonological processes occurring in different languages, such as assimilation, neutralization, deletion and epenthesis.

Carlisle (1994) reviews the evolution of studies focusing on the effect of the linguistic environment on phonological production, pointing out that the first accounts of the importance of the surrounding linguistic setting to the production of a determined variant are traced back to Labov's sociolinguistic research in the 1960s. The investigation of the influence of the adjacent sounds on the production of an L2 variable was pioneered by L. Dickerson (1975), and followed by other studies concerned with feature changing processes (e.g., W. Dickerson, 1976/1987; Dickerson & Dickerson, 1977; Edge, 1991). Tarone (1980/1987) provided the first evidence of the influence of the phonological environment on studies not dealing with feature changing processes. Although environment was not set up as a research variable, Carlisle (1991a) observes that an examination of Tarone's data demonstrates that the highest frequency of vowel epenthesis in word-final consonants occurred preceding a pause, decreased in the context of a following consonant, and was lowest before a vowel.

Carlisle's own work has aimed at examining the power of the environment in conditioning variability in L2 speech (Carlisle 1991a, 1991b, 1992, 1997, 2001). His research has investigated the production of /sC(C)/ onsets by Spanish speakers of L2 English, questioning the influence of a preceding consonant or a vowel on the occurrence of prothesis, that is, word initial epenthesis. Spanish speakers' predilection for vowel epenthesis in simplifying /sC(C)/ onset clusters has been attested in studies involving different L2s. Carlisle (2001) cites Tropf's (1987) study of L2 German, Schmid's (1997) study of Italian, and Abrahamsson's (1999) and Hyltestam and Lindberg's (1983) studies of Swedish. Of these studies, only Abrahamsson's investigated the influence of phonological context.

In Carlisle's first environmental studies (Carlisle, 1991a, 1991b, 1992) it was found that /sC/ onset clusters were significantly more often epenthesized if preceded by a consonant than if preceded by a vowel. The two studies reported in 1991a involved /st/, /sp/, and /sk/ onsets, the 1991b study contrasted /sl/ and /st/ clusters, and the 1992 study tested /sl/ and /sN/. The power of the phonological environment in conditioning syllable structure modification was strengthened by the fact that the rank orders of consonants and vowels were similar before the different onsets, as indicated by the positive and significant correlations among the environments before different onsets in the four experimental data sets. Rebello (1997) found a different trend from that of Carlisle in terms of environmental vowels and consonants. In her study BP speakers of L2 English epenthesized /sC/ and /sCC/ clusters more frequently in the environment of a vowel than of a consonant, although there was very little difference. The highest rate of epenthesis occurred in the environment of silence, a category not included in Carlisle's studies. In fact, the 'null' context, that is, /sC(C)/ preceded by silence, was the only type of environment that expressed a consistently high rate. Rebello suggests that

the reason for this prevalence of epenthesis in clusters at the beginning of an utterance may be that "in the stream of speech some instantiations of epenthetic vowel may be deleted, and may, therefore, surface much less often in the speech of learners than when they occur before a word . . . preceded by pause" (p. 106).

In Baptista and Silva Filho (1997) the rates of epenthesis for consonantal and vocalic contexts did not differ much, but coincided with the direction of the data in Tarone (1980/1987) – more epenthesis in the context of a consonant (13.6%) than in the context of a vowel (11.9%). For pauses, however, whereas Tarone's data showed the highest rates of the three types of contexts, Baptista and Silva Filho found the lowest rates in their study. One speculation that seems valid, in view of the transcriptions provided by Tarone, is that a large number of the pauses were, in fact, filled nonlexical pauses, characteristic of hesitations caused by the speakers' difficulties in producing spontaneous speech. Thus, the production of an epenthetic vowel in this setting cannot be attributed to the preceding final consonant nor to the following environment 'silence' or 'pause', but is part of the speakers' strategy to maintain speech flow while preparing the following utterance. The fact that a more pronounced difference occurred between the rate of epenthesis in vocalic and consonantal contexts and the rate of epenthesis before a pause (7.3%) led Baptista and Silva Filho to conclude that a continued flow of speech seems to be much more decisive in triggering word-final epenthesis than the difference between a vowel or consonant in the immediately following context.

Besides investigating the effect of the preceding phonological context, Carlisle (1991b, 1992, 1997, 2001) set out to examine the interaction of markedness of the target clusters with this effect. Target clusters in markedness relationships, either concerning cluster constituency or cluster length, were contrasted and examined for constraint power. In the first studies the results were strikingly consistent. Markedness relations

and phonological environment interacted in that the highest frequency of epenthesis occurred when the more marked cluster (/st/, in 1991b; and /sN/ in 1992) were preceded by a consonant, and the lowest frequency when the less marked cluster (/sl/ in both studies) was preceded by a vowel. Carlisle (1992) observes that, in fact, because consonantal codas are more marked than vocalic codas, the environments are also in markedness relationship, and markedness relations will operate in the sense that

> epenthesis should occur least frequently when the two less marked constraints are in conjunction; it should occur most frequently when the two more marked constraints are in conjunction; and an intermediate frequency of epenthesis should occur when a less marked constraint is in conjunction with a more marked constraint. (p. 70)

Carlisle (1997, 2001) examined less marked /sC/ onsets (/sp/ and /sk/), and more marked /sCC/onsets (/spr/ and /skr/). Consistent with the previous studies, epenthesis appeared significantly more often following consonantal contexts than following the vocalic ones. Also, consistent with other studies, the more marked/longer clusters triggered significantly more epenthesis than the less marked/shorter clusters. The interactive effect of the two constraints was not significant, though. The fact that in all four studies the vocalic environment ranked lowest, no matter what markedness relations existed between the clusters, led Carlisle to propose that environment was the most powerful constraint in accounting for epenthesis production.

Carlisle (1991a) acknowledged that examination of the data in this study seemed to indicate that the frequency of epenthesis could be inversely proportional to the sonority of the preceding environment, since more frequent epenthesis appeared in the context of obstruents, than of sonorants and finally of vowels. He observes that "the frequency of epenthesis before /sC/ onsets would be determined

by two interacting sets of constraints: the degree of sonority of the preceding environment and the sonority relations between the members of the onset" (p., 91). Carlisle does not examine this interaction of constraints, though, which is a major contribution of Rebello's (1997) and of Baptista and Silva Filho's (1997) studies to the field. These studies investigated the effect of sonority relations across syllables based on Hooper's (1976) SSC and the potentiality of Murray and Vennemann's (1983) SCL (see Section 2.6) to account for epenthesis production. The common hypothesis tested in both was that the greater the violation to the SCL the more likely would be the occurrence of re-syllabification.

The procedures adopted in analyzing strength values (the construct adopted by Hooper) across syllables followed the same steps in the two studies: (a) Consonantal strength values were assigned to each segment in the cross-syllabic contact according to Hooper's universal strength hierarchy (see Section 2.3). In Rebello's (1997) study the value of the target sound was held constant (/s/ = 5). In Baptista and Silva Filho (1997), values were assigned to the last consonant of the target word and to the first consonant of the following word, that is, to target and context sounds; and (b) the difference between each contrast, *a-b*, where according to the SCL, '*a*' was the strength value for the first sound in the cross-syllabic contact and '*b*' was the value for the second, was computed as the sequence syllable contact number (SCN). For example, in Rebello's study any sequence involving an environmental voiceless stop obtained the SCN=+1, because /p, t, k/ = 6, and /s/ = 5. In Baptista and Silva Filho, the sequence 'Jeff pays', for example, obtained the SCN=-1, since /f/=5, and /p/=6, whereas the sequence 'log was' obtained the SCN=+4, since /g/=5, and /w/=1.The prediction, according to the SCL was that epenthesis rate would increase as a function of the value of the SCN.

Thus, those sequences with a negative SCN would cause minimal epenthesis because they contained the preferred structure, that is, $a < b$, whereas those sequences with a positive SCN would cause greater rates of epenthesis.

In Rebello's study, contrary to expectations, more frequent epenthesis was produced with environmental segments of lesser strength values than with greater strength, although the difference was very small. Also, there was no tendency for epenthesis to increase or decrease with the degree of difference in strength across syllables. The production of /sC(C)/ clusters seems to have been affected more predominantly by the exceptionality of the /s/ sound itself, concerning the transferred L1 tendency to voice it in the environment of a following voiced segment, and by the lack of L2 fluency, which accounts for the speakers' inability to make assimilations between words. In the case of the environmental affricates, especially, this difficulty might explain the reason why it was the contact presenting the highest rate of epenthesis. The results in Baptista and Silva Filho (1997), on the other hand, corroborated the hypothesis, since epenthesis rates increased gradually from SCN – 4 to SCN 6, with only slight deviations in the rates for SCN 1, 4, and 6. The authors suggest that these minor deviations could be attributed to three main factors. First, they could be due to the limited scope of the study. Some SCNs had few tokens, and statistical tendencies would show up better with larger numbers. Second, L1 transfer could have interfered with the results making final /s/ and /z/ easier, or in other words, less prone to epenthesis. In fact, as pointed out before, analysis of the data and results indicates that final /m/ and /n/ should be considered in these terms, as well. Third, the results might be seen having in mind that they are limited to the application of the strength values of a given scale, and there is no consensus as to the most adequate hierarchy. In spite of these possible interfering factors, as the authors point out, the general tendency was for

strength relations across syllable boundaries to affect final consonant epenthesis in the direction of the predictions made by Murray and Vennemann's (1983) SCL.

3.4 Conclusion

The body of research reviewed in this chapter sets the field for the investigation of the influence of markedness relations and phonological environment on the production of an L2 English error by BP speakers – word-final vowel epenthesis, the object of this dissertation. Concerning the syllabic system of BP and English, the concept of markedness applies to the structural differences in the complexity of onsets and codas. The less complex structure of Portuguese is less marked and more closely related to the universal canonical CV syllable than the more complex English syllable. According to the predictions of Eckman's (1977/1987a) MDH, these markedness relationships are expected to interfere with L2 English syllable production by BP speakers in that the more marked English structure will cause difficulties for speakers whose phonological system is molded on less marked structures. Evidence of difficulty in this direction can be observed in the production of complex onsets such as the /sC(C)/ clusters examined by Rebello (1997), for example, and in the production of single-final consonants, as examined by Baptista and Silva Filho (1997). Although these studies are small in scope and indubitably much research is needed before claims can be made, they have certainly pointed in interesting directions. Baptista and Silva Filho's conclusions concerning the investigation of markedness relations are that markedness both in voicing and, among voiced stops, in place of articulation showed results predicted by markedness relations alone. On the other hand, the investigation of sonority, through the contrasting of

sonorants and obstruents and through the comparison of sonority level within the class of obstruents, showed that markedness relations and L1 transfer operate interactively in shaping these productions, so that the MDH alone cannot account for them.

The investigation of the effect of the phonological environment on final consonant production indicated that differentiated degrees of difficulty may be posited by the presence or absence of an adjacent sound, and that in case of juxtaposition of sounds, the presence of a following consonant brings about a more complex relation between the segments in contact. In this case, "the difficulty in producing the target consonant appears to depend not so much on the class of the context consonant itself, but on the interaction between the class of the target final consonant and the class of the context syllable-initial consonant" (Baptista & Silva Filho, 1997, p. 32).

Thus, concerning the theoretical background on which the hypotheses for the study are built, the pattern of results obtained by Baptista and Silva Filho makes it possible to establish the following relations: (a) the effect of markedness is permeated by L1 transfer to a large extent; (b) the cross-syllabic relations posited for primary languages by the SCL seem to hold true for IL as well, supporting the SCH; and (c) markedness relations of the target interact with those of the phonological context in word-final epenthesis production.

It must be observed that there seems to be a tendency in interphonology studies concerning the syllable to conclude that transfer, language universals and environmental constraints interact with markedness. Probably one advantage of analyzing language phenomena from the point of view of markedness relations is that it allows for these other factors. All in all, phonological IL productions, seen from the perspectives of markedness relations and environmental constraints, have proved to be a field of insightful study both to clarify language acquisition factors and to test linguistic theories.

CHAPTER 4

PERCEPTION AND PRODUCTION IN IL PHONOLOGY

4.1 Introduction

Speech perception is basically a decoding activity that involves extracting "identifiable linguistic elements from the continuous acoustic signal of speech" (Trask, 1996, p. 330).

According to Strange (1995), the study of speech perception is relatively recent and was launched by the invention of the spectrograph and the acoustic speech synthesizer in the late 40s. Early studies on speech perception soon identified the lack of "correspondence between segments of the acoustic signal on the one hand and perceived units as they were characterized by phoneticians/phonologists on the other" (Strange, 1995, p. 4).

Cross-language speech perception research, which started to develop two decades later, has reinforced this conclusion and has contributed to the development of the field, providing data that makes it possible to identify the existence of universal phenomena of speech perception (Jenkins & Yeni-Komshian, 1995, p. 464).

Drawing a parallel between L1 and L2 speech acquisition, Flege (1995) says that whereas findings from L1 research, although inconclusive, tend to point to motoric difficulty as the principal cause of segmental mispronunciations of normally developing children, L2 research provides evidence of a perceptual basis for learners' pronunciation difficulties.

This chapter presents an overview of some theoretical issues and empirical

findings concerned with the question of the relationship between L2 speech perception and production. The overview is basically structured within the framework of the Speech Learning Model (SLM) of Flege and colleagues (see Flege, 1995), an influential L2 pronunciation acquisition model that has spawned a remarkable number of research programs on L2 speech perception and production by adults. The chapter starts by addressing the issue of age-related constraints on L2 pronunciation acquisition, then it describes the points of the SLM that are of specific relevance to the present research, presents discussions on the question of the identification of the mental unit of speech perception and production, and provides an overview of the main lines of research on the relationship between L2 speech perception and production. The last section is devoted to a description of the speech perception assessment techniques most frequently employed in recent research. Special attention is given to the description of the perception test employed in this study, the categorical discrimination test (CDT).

4.2 Perceptual foreign accent

Research has demonstrated that, on the one hand, sensitivity to the prosodic properties of L1 utterances seems to be present at birth. For example, using the High Amplitude Sucking (HAS) technique Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, Amiel-Tison (1988) showed that infants as young as four days old were able to distinguish between utterances in their mother's native language and those of another language. According to Armitage, Baldwin, and Vince (1980, cited in Jusczyk, Hohne, & Mandel, 1995, p. 97) this early sensitivity to L1 global features is due to prenatal exposure because the uterine wall, acting as a low-pass filter, transmits characteristics

associated with prosody more successfully than segmental features.

On the other hand, research has also demonstrated that sensitivity to more 'fine-grained aspects' of the L1 is not present at birth, so that humans are endowed with a perceptual system that enables them to segment speech sounds in a linguisticly relevant way independent of the language they are exposed to (e.g., Eimas, 1974, 1975; Eimas, Siquelend, Jusczyk & Vigorito, 1971). This sensitivity to more 'fine-grained aspects' of L1 sound patterns develops in early infancy, though, and much of the discussion in pioneering studies in the early 1970s focused on defining when and how the change occurs from "infants' initial language-general phonetic perception to a language-specific pattern" (Kuhl, 1993, p. 125) molded by the L1. Studies reported in Jusczyk et al. (1995) indicate that sensitivity to many of the properties of segmental units in the native language begins to develop between the early ages of 4 ½ and 9 months. Another substantial amount of research reviewed by Werker and Polka (1993) and Kuhl (1993) has determined the crucial time of perceptual change to be around the first year of life (e.g., Best & McRoberts, 1989; Werker & Lalonde, 1988; Werker & Tees, 1984). Because this change coincides with the onset of word acquisition, the authors remark that it seems plausible that it is a consequence of children's developing awareness of word meaning. Jusczyk et al. (1995) cite research of Jusczyk (1992, 1993, and 1994), indicating that in developing capability for native-language word perception, sensitivity to finer distinctions increases, whereas sensitivity to non-relevant dimensions decreases. The formation of this 'weighting scheme' is indicated as a possible cause of the changes in speech perception occurring during the first year of life, which end up generating language-specific perceptual patterns. Thus, changes in the attentional demands during the first years of life are thought to explain changes in phonetic sensitivity in speech processing.

According to Werker and Polka (1993), the data already gathered on the issue of speech perception development consistently indicates that (a) the most significant changes in native language speech perception occur between the ages of two and six years; (b) like adults, children show advantage in the perception of native over nonnative sounds. At the age of four, children show difficulty in distinguishing nonnative contrasts, their perceptual difficulties approximating adult patterns; and (c) while children modify their perception of nonnative contrasts in the course of L2 learning, adults tend to rely on the acoustic parameters of similar contrasts of the L1.

As remarked by McAllister (1996), the point of departure of speech perception research is that not only deviant production, but also perceptual difficulties reflect L2 learners' reduced phonetic/phonological capacity.

According to Strange (1995), studies carried out in the 1980s and early 1990s investigating a wide range of language contacts showed strong evidence for L1 patterns to be employed in adults' perception of L2 consonants and vowels. This tendency of the adult L2 perceiver to rely on the L1 phonetic parameters was termed by the author *perceptual foreign accent*, a perceptual correspondent to the concept of foreign accent. McAllister considers that the range of degree of perceptual foreign accent is large, varying as a function of the L2 speaker's experience in the language.

Drawing on Flege (1995, p. 237), it can be said that L2 speakers perceive with accent when they interpret the target language auditory input "through the grid" (Wode, 1978) of the L1, which diverges from the L2 "phonetic norms along a wide range of segmental and suprasegmental (i.e., prosodic) dimensions" (Flege, 1995, p. 233). Flege cites two studies illustrating L1 influence at the segmental level: Rochet (1995), which showed that whereas Portuguese L2 speakers of French seemed to hear /y/ as /i/, English learners seemed to hear it as /u/; and Weinberger (1990), which showed that

Japanese L2 speakers of English mispronounced /θ/ as /s/, whereas Russian learners mispronounced it as /t/. Studies on L2 vowel perception also show this L1 background influence on perception (e.g, Beddor & Strange, 1982; Flege, Munro & Fox, 1994). As Bohn (1995) remarks, these studies are built on the already classic claim of Trubetzkoy (1939) that nonnative speech sounds are interpreted *through the sieve* of the L1 phonological system, and deal with what Bohn characterizes as "probably the best-documented finding in cross-language perception research" (p. 279) – the influence of the L1 on adults' L2 speech perception.

The discussion about age-related difficulties is frequent and rich in the literature on L2 speech acquisition/learning. Traditionally, the issue has been treated in the light of the "Critical Period Hypothesis" (CPH), originally proposed by Lenneberg (1967, see Ellis, 1986, p. 107), which postulates a biological maturation constraint for language learning. The hypothesis proposes that this critical period would extend approximately from two years to puberty. Owing to the cerebral lateralization that occurs after puberty, accompanied by an assumed loss of neurological plasticity of the brain, humans are supposed to decline in their ability to acquire/learn foreign languages after that period.

Criticism of the CPH has been supported by counter-evidence for this posited biological hindrance. In a recent study, Wang, Sereno, Jongman, and Hirsch (2000, p. 511), for example, cite research (Perani et al., 1998) showing that experience continuously shapes cortical representations. Data from the Wang et al. study itself, employing magnetic resonance imaging, indicate that the adult's brain preserves its capacity to change. Cortical changes witnessed in the experiment provided evidence of neural plasticity in the L2 learning process.

Not only has there been neurophysiological research presenting counter-evidence to the posited biological limitation of adults, but there has also been linguistic research

presenting L2 pronunciation performance outcomes contradicting the CPH. On the one hand, accented pronunciation has been found in L2 learners whose initial contact with the language occurred before the age of seven (Flege & Fletcher, 1992) or even before the age of four years (Flege, Munro, & Mackay, 1995a; Thompson, 1991). Moreover, concerning speech perception specifically, Werker and Tees (1983, cited in Strange, 1995, p. 34) reported evidence that 3- to 4-year-olds present difficulty with L2 phonetic contrasts at an initial stage of acquisition. On the other hand, research data has provided evidence that some strongly motivated learners who begin contact with the L2 after the hypothesized critical period achieve good pronunciation (e.g., Bongaerts, Planken, & Schils, 1995, cited in Flege, 1997, p. 79), contradicting the claim for adults' inability to achieve successful L2 pronunciation performance. In fact, research on the effect of age has provided evidence of a sensitive period for acquisition – the earlier the better (Flege, 1988b; Flege & Fletcher, 1992; Thompson, 1991). For example, there has been considerable research showing that late bilinguals often produce L2 vowels with a foreign accent (e.g., Major, 1987c; Flege, 1992; Flege, Bohn, & Jang, 1997; Flege, MacKay, & Meador, 1999; Munro, 1993). However, it has not been possible to isolate age as the exclusive or even decisive cause of the lack of good pronunciation achievement. Flege et al. (1995a) showed that age of learning (AOL) correlated with foreign accent in the English of 240 LI Italian speakers who initiated contact with the L2 between the ages of 3 and 21 years, and were living in Canada for over 30 years, on average, at testing time. However, the data did not show a sharp decline in L2 pronunciation accuracy around adolescence as posited by the CPH (or at any other particular age). Instead, it showed a linear decrease of production accuracy, or rather, increased accent, with age of learning. In his discussion of the difficulty in isolating age as a determining factor of influence on L2 acquisition, Flege (1997) says that the CPH

cannot be tested directly because

> many factors that might conceivably influence speech learning are inevitably confounded with chronological age, ... For example, subjects' age of first exposure to an L2 in a predominantly L2-speaking environment may be related to their strength of emotional attachment to the L1-speaking community and/or their willingness to sound just like members of the L2-speaking culture. To take another example, either length of residence in an L2-speaking environment or chronological age must be confounded in a research design meant to compare groups of subjects differing in their age of arrival in an-L2 speaking environment. (p. 79)

Alternative explanations to the CPH for adults' difficulty to achieve native-like speech parameters are offered in terms of psycho-cognitive, socio-cultural, and instructional factors. As suggested by Flege, Munro, and MacKay (1995b), the causes of difficulty may be "neurofunctional reorganization which affects the storage of new phonetic information in long-term memory, cognitive changes which affect processing, or psychological and/or sociolinguistic factors" (p. 2). Neufeld (1980) attributes age constraints to circumstances of learning. He says that whereas children acquire inductively, in naturalistic situations, adults learn deductively and, in general, in formal, instructional contexts. Leather and James (1991) consider that "experience-related differences in auditory attention to speech" (p. 307) may account for the adults' supposed disadvantage over children. The authors cite the idea of an "attentional resource allocation" hypothesis relating ability with training. Mastery of the L2 sound system is also related to the time elapsed between events of language learning. Discontinuity in language learning, rather than age, is pointed out by the authors as a determinant factor in this view.

Degree of exposure to the L2 and of activation of the L1 in an L2 environment have also been indicated as factors affecting adults' L2 perception and production. Concerning the former, studies have shown that extensive exposure to the L2 may influence both perception and production positively (Best & Strange, 1992; Bohn &

Flege, 1996; Flege, 1987b; Flege et al., 1999; Hammaberg, 1990; Wieden, 1990; Yamada, 1995). In regard to the latter, studies have demonstrated that even early L2 learners may not achieve native-like L2 pronunciation if L1 use is frequent (e.g., Flege, et al., 1997; Flege, Frieda, & Nozawa, 1997; Guion, Flege, & Loftin, 2000; Piske & MacKay, 1999; Riney & Flege, 1998).

Flege et al. (1999) say that the apparent contradictory results concerning vowel perception in their study, which showed that early Italian bilinguals reached native-like performance in the perception of English vowels, and other studies (Pallier et al., 1997; Sebastian-Gallés & Soto-Faraco, 1999, both cited in Flege et al., 1999, p. 12), which found that early Spanish/Catalan bilinguals perception performance was strongly influenced by the L1, may be explained by the differences in the degree of activation of the L1. Whereas subjects' use of the L1 in Flege et al.'s (1999) study was very restricted, the subjects in the other two studies used L1 more frequently.

Counter-evidence to the claim for adults' inability to achieve native-like pronunciation patterns are also apparent in studies indicating that discrimination of nonnative contrasts can improve with training (e.g., Logan, Lively, & Pisoni, 1991). Flege (1995, and elsewhere) argues that the decisive factor for adults' difficulties in acquiring/learning L2 speech is the stabilization of L1 parameters, deeply rooted by their prolonged experience in a monolingual environment.

Jusczyk (1985, cited in Flege, 1995, p. 265) suggests that the stabilization of L1 phonetic parameters occurs at the age of 5 or 6 years, when children begin learning to read. Prior to that, he claims, allophonic variants may not be associated with a single phonemic category, since younger children rely on purely sensory information, and thus are more prone to detect auditory-acoustic details. L1 stabilization as a cause of constraints on L2 phonetic acquisition is one of the central hypotheses of the SLM, the

model of L2 acquisition accounting for age-related differences in pronunciation achievement developed by Flege and co-workers during the last decade (see Flege, 1995).

4.3 The Speech Learning Model (SLM)

In Flege's (http://main.uab.edu/show.asp?durki=42171) words, the SLM core hypothesis is that "the age-related effects seen in studies of speech production and perception arise from differences in how the L1 and L2 systems interact, and that how the systems interact depends on the state of development of the LI phonetic system at the time L2 learning begins." Since L1 and L2 sounds co-exist in the phonological space, the full establishment of phonetic categories for L1 will impede L2 subsequent category formation because, as mentioned before, the sounds of the L2 are interpreted through the 'grid' or 'sieve' of the L1 phonetic system.

According to Flege (1996), research data seems to indicate that previous L1 acquisition affects subsequent L2 learning "through the intermediary of central cognitive-linguistic and phonetic structures more abstract than the sensorimotor level implied by a sensitive period hypothesis" (p.12).

Onset of reading is proposed as the turning point for L1 stabilization, because it promotes systematization of language parameters. In this view, the acquisition/learning of an L2 after L1 systematization takes place will require a certain degree of L1 de-systematization, to give space for the L2 to be established as an independent system (L. Scliar Cabral, personal communication, June, 2000). Pennington (1998) refers to the de-systematization process as 'breaking the phonological habit' of the LI. She explains that the adult learner not only is deprived of the child's "better position for acquiring the

phonology of the second language in a direct, naïve and uninhibited way" (p. 332), but also has to deal with the complex task of breaking the phonological habit of the L1, which operates on several levels: perceptual, motor, cognitive, psychological, and socio-cultural.

Flege (1996) cites research proposing that learning to read seems to stimulate a segmental level of analysis, fostering phonemic awareness (e.g., Bradley-Bryant, 1983; Liberman et al., 1974; Kirtley et al., 1989; Morais et al., 1979). He defines an *early* L2 learner as an individual who is exposed to the language prior to the age of 5-6 years, and a *late* learner as one who begins L2 contact after that. The SLM works with the hypothesis that differential behavior of early and late learners in terms of foreign accent is the result of the interaction between the two phonetic systems. Longer and more substantial experience in a monolingual context makes late learners' speech perception and production more tightly attuned to the L1 system. In other words, L1 systematization functions as a barrier blocking optimal L2 phonetic acquisition, that is, causing foreign accent, because the sounds of the latter are perceived and produced with reference to the inventory of speech sounds of the former.

The postulates and hypotheses of the SLM are presented in Flege (1995, p. 239) as follows:

Postulates

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

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

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

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

Hypotheses

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

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

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

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

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

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

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

Considerable work has been done in the area of cross-language speech perception and production putting the hypotheses of the SLM to test. Research attempting to unravel the complexities of age-related constraints to phonetic acquisition, for example, has been concerned with the neutralization of the many intervening variables operating when different age groups are studied, which makes it almost impossible to isolate age as a single source of influence. Accounting for this shortcoming of previous research, Flege et al. (1995a), Flege et al. (1995b), and Munro, Flege, and MacKay (1996) examined a wide range of ages of learning, attempting to relate degree of global accent and segmental production accuracy with age. Overall results of these studies together show a systematic decrease of segmental production accuracy or increase of accent as age of learning increases. The three questions triggering much of the age-related investigations related to the SLM are "(1) What is the *earliest* AOL at which persistent foreign accents become common? (2) What is the *latest* AOL at which accent-free pronunciation of an L2 remains possible? (3) Does the critical period for speech

learning affect all individuals?" (Flege et al., 1995a, p. 3125). It must be concluded from the research reported in the previous sections that, to the present date, inconsistent findings make it impossible to advance definite answers to these questions. Much research is needed, as a starting point, on L1 acquisition concerning the complex issues related to chronological development and the process of phonetic category formation long before robust evidence can point confidently in any one direction concerning L2 acquisition.

The notion of category formation permeates the SLM, in proposing that the ability to establish phonetic categories for speech sounds is not lost with age. Categorial[12] perception is the mapping process that operates in the representation of information. The development of this natural perceptual schema of representations is inherent in human nature. In the literature on speech perception, the classic study of Liberman, Harris, Hoffman, and Griffith (1957) and Pisoni and Tash's (1974) study on consonantal discrimination are constantly cited as genuine illustrations of how the mechanism of categorial perception operates (see Miller & Jusczyk, 1989). In the first study, for example, subjects were presented with a continuum of syllables ranging from /be/ to /ge/ and were asked to label the presentations as /be/, /de/, or /ge/. Although the stimuli varied equally across the formant transitions, subjects consistently assigned them to one of the three discrete phonetic categories. Further laboratory tests showed that subjects rely on the phonetic categories in discrimination tasks. Even though "the stimuli formed a physical continuum, perception was not continuous, but categorical" (Miller & Jusczyk, 1989, p. 115). The operation of the categorial perception system is far from simple. It does not occur in a linear fashion, but at levels of processing ranging

[12] Both 'categorial' and 'categorical' appear in the literature. The first term was adopted in the present dissertation.

from unconscious processing of 'unperceived' physical differences in the continuum to their identification with one specific target or another.

The phenomenon of categorial perception has been cited as evidence both for the psychological reality of phonemes and for characterizing speech perception as a specialized mode distinct from sound perception in general. In speech perception, category formation of the smallest units of spoken language – phonemes – involves the problem of lack of invariance because, as remarked by Strange (1995), "there is no one-to-one correspondence between phonemes as perceived and acoustic patterns generated by speech gestures that constitute the stimuli for speech perception" (p. 5). Thus, two possibilities are likely to happen: (a) a many-to-one correspondence, when different phones are successfully categorized as the same phoneme (in this categorization, auditorily detectable differences that are not phonetically relevant are not taken into account); and (b) a one-to-many correspondence, when a single acoustic stimulus is unsuccessfully categorized as different phonemes, probably owing to varying contexts of occurrence, or production at different rates of speech, or by different talkers.

Strange (1995) suggests explanations for perceivers' ability to categorize speech stimuli in the face of lack of constancy, within the domain of three theories. The first two, postulated primarily for visual perception, are built on the premise that the stimulus is inherently ambiguous. The third theory rejects this view, proposing that this supposed ambiguity is simply a result of inappropriate analysis. The first perception theory, the associative learning theory, proposes categorization by association of inherently ambiguous stimuli with other previously disambiguated experiences. The second, the nativist theory, proposes innate mental categorization. The third theory, the direct realist theory, is built on the premise that the perceiver detects the constant patterns that uniquely specify the object of perception directly from the stimulus. That is,

information about the object of perception is picked up without intermediation of innate knowledge or mental associations. The influence of these general perception theories can be seen in the evolution of speech perception theories, as explained by Strange (1995, p. 5): The first two general perception theories independently influenced the motor theory of Liberman et al. (1967) and the feature detector models of Eimas and Corbit (1973), respectively, as well as the revised motor theory of Liberman and Mattingly (1985), which combines the other two speech perception theories. The influence of the direct realist theory can be seen in the speech perception approach taken by Fowler (1986), and in the more recent work of Best and colleagues (e.g., Best, McRoberts, & Sithole, 1988; Best & Strange, 1992).

Primordial in any and all theories of speech perception is the question of how speech perceivers pick up the invariant aspects of the stimuli and interpret, that is, categorize these stimuli. In other words, the one basic question inherent to all the theories is the definition of the criteria for establishing category boundaries. It is discussed whether the metric employed in speech sound categorization is based on criteria in the articulatory domain, in the acoustic domain, or in the combination of both (see Best, 1995; Kuhl & Iverson, 1995; Pisoni & Lively, 1995 for comprehensive discussions).

It is based on the notion of phonetic category formation that the relationship between L1 and L2 speech perception and production has been investigated in research conducted on the postulates and hypotheses of the SLM. In the view proposed by the model, perception and production of L2 phones is mediated by the association of these phones to phonetic prototypes established as the ideal members of L1 categories (see Kuhl & Iverson, 1995), that is, the previous full establishment and long use of L1 phonetic categories regulates adults' formation of L2 categories.

The SLM hypothesizes that the condition for establishing a new phonetic category for an L2 sound is that it passes the filter of equivalence classification for lack of identification with an L1 counterpart.

Flege (1996) characterizes equivalence classification as "a basic cognitive mechanism thought to shape both L1 and L2 speech learning" (p. 13), and Hammarberg (1996) explains that "the condition of perceived equivalence is met if the learner perceives an element (structure, category, rule, etc.) in the target language and one in the native language as sufficiently similar to pass as equivalent" (p. 163).

Wode (1995, p. 331) observes that because

> no language uses the entire perceptual space . . . . [foreign language] categories may be localized in a perceptual space not used in the L1. Such sounds are perceived as new . . . . Because they do not compete with prior categories, there is no basis for transfer. To create these new categories, L2 and/or L3 learners activate their original innate sensitivities in response to the external stimulation by the L2 and L3 input, respectively.

The SLM operates with the classification of L2 phones as *identical*, *similar*, or *new* in relation to L1 phones, and the discussion in the literature on criteria employed in this classification points in three directions: (a) the phonetic symbol; (b) acoustic similarity; and (c) listeners' perceptual judgments of L1 and L2 phones (Flege, 1991, 1996; Rochet, 1995). According to these criteria, first, identical and similar L1 and L2 phones are represented by the same International Phonetic Alphabet (IPA) symbols, whereas new L2 sounds are represented by a phonetic symbol not used in the L1 inventory. Second, an identical L2 sound does not present a significant acoustic difference from the L1 sound represented by the same IPA symbol, whereas a similar L2 sound differs acoustically from the L1 sharing the IPA symbol, and a new sound does not acoustically resemble any L1 sound. Third, native listeners cannot detect any difference between the identical L2 and L1 sounds, but are able to discriminate the

similar L2 sound from that of the L1 and, naturally, to recognize a new sound as not belonging to their L1 repertoire (Flege, 1991, 1996).

Flege points out that the problem with the phonetic symbol criterion is the plurality of phonetic transcription systems in use. He notes that because of the lack of agreement in the choice of a phonetic system the distinction between the English /i/-/ɪ/ or /i:/-/i/ will lead to diverse predictions about Spanish L2 English speakers' production, since "symbolizing the lax vowel as /ɪ/ suggests that it will be regarded as a new vowel . . . whereas symbolizing it as a short /i/ suggests that it will be regarded as a similar vowel" (Flege, 1996, p. 43). Rochet (1995) adds to Flege's criticism, arguing that the IPA criterion requires the uncommon use of very detailed phonetic transcriptions to account for subtleties that, if not taken into account, can lead to erroneous classifications. He points out further examples where the IPA criterion fails to render an appropriate classification. One example is that because French and English word-initial stops are represented by the same phonetic symbols, the IPA criterion leads to the conclusion that none of these phonetic categories is to be considered 'new', which in fact occurs; however, whereas French /p, t, k/ are often perceived by English speakers as /b, d, g/, English /b, d, g/ are often perceived as /p, t, k/ by French speakers. This situation shows that "the fact that an L2 phone is represented by the same IPA symbol in broad transcription as a given L1 phone does not mean that the L2 phone in question will be perceived as belonging to the same phonemic category as that of the L1 phone" (Rochet, p. 387). Another example is that because English /θ/ does not exist in the inventory of phonetic symbols of French (the same is true for BP), the criterion leads to its classification as a new category; however, in both L1s the phone is perceived not as a new one, but as one of the other fricatives or stops present in the L1 inventory,

depending on the linguistic environment and position in the word. This situation shows that the representation of an L2 phone by a phonetic symbol not present in the L1 does not mean that it will be perceived as a new category.

As Rochet (1995) pertinently remarks, the terms identical, new and similar are "labels for describing the way in which L2 phones are perceived by the L2 learners" (p. 390). The perceptual criterion is clearly stated in Hypothesis 5 of the SLM which predicts that when the mechanism of equivalence classification occurs, "a single phonetic category will be used to process perceptually linked L1 and L2 sounds (diaphones)" (Flege, 1995, p. 238).

It seems reasonable to argue in favor of the perceptual criterion for the process of equivalence classification, since the question at stake is the question of how L2 learners relate L1-L2 sounds, and not how linguistic theory describes the languages as phonetic/phonological systems.

The major underlying unresolved question permeating this discussion, however, is the question of the criteria (or metric) employed in establishing L1 category boundaries per se, as mentioned before, and consequently, the criteria employed in interlingual associations. Because it has not been possible to determine precisely how speech sounds are perceived/categorized (if on a proprioceptive or on an acoustic basis, or on the combination of both), it has not been possible to determine the exact metric on which interlingual identifications are taken.

Flege (1995, p. 264) says that as Ladefoged (1990) pointed out, the sensory (auditory, visual) metric does not seem to suffice, since even judgments of highly trained phoneticians may be biased by use of different thresholds, for example; and that the gestural metric suggested by Browman & Goldstein (1990) and Best (1995) may be appealing, but difficult to apply. A third proposal cited in Flege (p. 264) is that of James

(1984) that a gestural, acoustic phonetic and abstract phonological metric may be employed in gauging the degree of perceived L1-L2 phonetic distance, depending on syllable position.

Rochet (1995) makes the point that "perception of L2 phones is not restricted to the auditory mode and . . . categorization (or equivalence classification) can result from orthographic representations, occurrence in cognate words, visual information, and so forth (which give away the category)" (p. 392).

An interesting suggestion by Flege (1991) is that refined laboratory tests may help to determine whether L2 phones are classified as similar or new. One possibility would be testing for speed of processing. Since new sounds might require a longer processing time than similar sounds, which in turn might take longer than identical sounds, speed of processing could help to clarify the matter. Another possibility would be testing for variability. Since an L2 sound recognized as similar to an L1 may be replaced by a single 'merger', the probability that this merger remains stable is high. On the other hand, the new L2 sound may be replaced variably because of the L2 learner's uncertainty about its properties.

Differential behavior in terms of L2 identical, similar and new sounds is described by Wode (1995, p. 323) in the following way: (a) identical sounds are handled via pre-existing categories; (b) similar L2 sounds "feed into pre-existing categories . . . . [and consequently] are handled easily and quickly in borrowing, pidginization, and L2 acquisition; but they are prone to interference, that is, transfer of phonological properties of the L1 onto the L2". As the result of this transfer, that is, by the process of equivalence classification, the L2 learner may establish an inaccurate perceptual target (Flege (1987a, p. 31) characterizes this as "a merger of the phonetic properties" of the similar L2 and L1 sounds); and (c) as mentioned above, new phones trigger the innate

process of category creation, and they do not compete with existing categories; that is, because their perceptual space is vacant, learners tend to be successful in their acquisition, although it may take some time.

In this sense, the SLM generates the hypothesis that after the L1 stabilization period, at 5-7 years, with onset of reading, additional categories are more easily established for new than for similar L2 sounds (Flege, 1995, and elsewhere). Owing to the operation of equivalence classification, the model works with the possibility that at an early stage of learning all L2 sounds are categorized according to the L1, then gradually, with continuous contact, some L2 sounds begin to be differentiated from the resembling L1 sounds up to the point that they (hopefully) reach successful categorization as a new sound. Leather and James (1996) report that a large number of studies by Flege and colleagues led to the conclusion that

> the 'phonetic distance' status of the phones involved provides a reliable predictor of the TL accuracy with which phones will be realized in the L2. Whereas a 'new' phone in the L2 (i.e., one not present in the L1) is shown to be masterable in acquisition, 'similar' phones are consistently produced (and perceived) with nontarget values. 'Identical' L2-L1 phones, on the other hand, provide little problem for acquisition. (p. 289)

Studies testing the superiority of the new sounds in L2 language acquisition (e.g., Flege, 1987b, 1988c) found that language experience did not affect the production of similar sounds. Even highly experienced L2 speakers failed to produce similar sounds with accuracy. However, it influenced positively the production of a new sound, since beginning speakers presented poor performance production whereas highly experienced speakers reached native-like authenticity. On the other hand, Flege (1991) also reports on research pointing in the opposite direction, that is, showing greater facility in the production of similar sounds (e.g., Altenberg & Vago, 1987; Briere, 1966) and difficulty in acquiring new L2 sounds. It must be noted that in the former study, there

are grounds to believe that the sound classified as new, based on the phonemic inventories of the L1 and L2, was, in fact, perceived as similar to an L1 phone by the L2 speakers investigated.

Concerning the newness of L2 sounds, an interesting observation is made by Rochet (1995, p. 392). The author makes the point that in face of the multiplicity of criteria on which L2-L1 phones may be associated (at the phonetic or phonological level, or as a combination of both; or specifically making use of articulatory, acoustic, visual, orthographic cues, or combinations of cues, etc), truly new L2 phones are rare. That being so, the notion of new phone meaning not perceived as belonging to an L1 category is not valid, because it is likely that all L2 phones are perceived (at least by late L2 learners) as belonging to some L1 category. Understanding how these associations are made, then, is crucial.

Flege (1995) says that although it is not possible to provide definite answers to the questions of what kinds of features the L2 learner uses as he/she begins to analyze the phonic elements of the L2, and what kinds of features are used once more familiarity with the L2 sound system has been acquired, some points can be made. Among these points, he proposes that "features may be evaluated differently as a function of the position in the syllable" (p.268). He reports phonotactic interpretation of English vowels and consonants in Browman and Goldstein (1990) and Samuel, Kat, and Tartter's (1984), respectively. The latter study indicated that listeners processed initial, medial, and final consonants differently. In terms of L2 processing, Flege (1995, p. 268) cites James (1988), Major (1986), Pisoni and Lively (1995), Sheldon and Strange (1982), and Wieden (1990) as studies presenting evidence that "the perceptual difficulty of a novel L2 phonemic contrast may vary according to syllable position"; and Morosan and Jamieson's (1989) study, which showed that although perceptual transfer of training

occurred across consonant place of articulation and vocalic context, it did not occur at the level of word position, suggesting that "listeners may learn 'syllabically'".

Rochet (1995) also considers that perception of L2 phones is affected by their physical properties in different contexts or by the phonotactic conditioning, since the phonetic context operates via "a set of templates" (p. 406). He remarks that the results of his experiments on L2 French pronunciation perception and production by Canadian English and BP speakers, and on the effect of perception training on the L2 French perception and production by Mandarin Chinese speakers corroborate previous studies (Pisoni & Luce, 1987; Pisoni, Logan, & Lively, 1992, both cited on p. 404) indicating that subjects learn L2 contrasts in a highly context-dependent way.

Transfer of phonotactic patterns is widely attested in the literature of L2 pronunciation. Strange (1995) remarks that the degree of difficulty of L2 beginners may vary as a factor of "the psychophysical salience of the acoustic parameters differentiating phonetic contrasts, similarities and differences in the phonetic structure of the L1 and L2 categories, and the phonetic and phonotactic contexts in which contrasts occur" (p. 39).

One hypothesis of the SLM related to phonotactic interpretations is of particular interest to the present study – the hypothesis that L2 and L1 sounds are perceptually related at a 'position-sensitive allophonic level', not at a phonemic level. Concerning the perception and production of word-final consonants, **H1** predicts that

> speakers of an L1 without word-final stops will not relate English word-final stops perceptually to word-medial or word-initial stops in their L1. If so, then we might expect them to eventually produce word-final stops in English accurately. This is because if **H1** is correct, L1 phonetic structures should not interfere with the establishment of new phonetic categories. (Flege, 1995, p. 261)

Flege comments that contrary to H1, research has shown that L2 speakers of different L1s without word-final consonants employ remedial measures to word-final

consonants such as stop devoicing, vowel epenthesis and consonant deletion. In the case of devoicing, though, a position allophonic level of analysis seems to operate, just as predicted in H1, since speakers of L1s that allow only voiceless consonants in this position tend to devoice the L2 voiced consonants in the same position. Equally, deletion seems to be a 'natural' strategy resulting from position-allophonic perception of the L2 by speakers of L1s that do not have word-final consonants. However, why some groups of L1s that do not have final consonants choose to delete and others to epenthesize is not fully explained, most arguments pointing in the direction of transference of L1 acquisition processes.

Embedded in the discussion above is the one pivotal question raised in psycholinguistic research that began to direct close attention to speech processing in the last decades – the definition of the unit of speech perception analysis.

The SLM predictions are basically concerned with the segmental dimension of speech (phoneme-sized units). Studies by Flege and colleagues (e.g., Bohn & Flege,1992; Flege, 1987a, 1987c, 1988c, 1989, 1996; Flege & Eefting, 1987; Flege & Hillenbrand, 1984) have focused on acoustic properties of L1 and L2 phones (VOT for stops, formant values for vowels), characterizing the units of speech perception. However, as Flege himself (1995) comments, "nonsegmental (i.e., prosodic) dimensions are an important source of foreign accent" (p. 233). At a nonsegmental level, the unit of speech perception extended to sequences of phones may account for foreign accent in terms of epenthesis production.

Leather and James (1996) remark that different properties of the L2 target may be picked out and related to an L1 sound at different stages of acquisition, with reference to different units (segments, syllables) of identification. They observe that in L1-L2 identifications (as proposed in the SLM), connections must be made between phonetic

and phonological interpretations, concluding that future investigations may benefit from an analytic framework of "models of sound description that posit a direct link between phonological specification and sensorimotor properties of speech" (p. 289).

4.4 The unit of speech perception

At the center of the challenging discussion of the identification of the psychological unit of speech perception, phoneme-sized and syllable-sized representations emerge as strong candidates for cross-language associations.

These have been investigated as natural candidates for the post of minimal units of speech segmentation in a considerable number of experiments on native language processing (e.g., Bradley, Sánchez-Casas, & García-Albea, 1993; Mehler, Dommergues, Frauenfelder, & Segui, 1981; Morais, Content, Cary, Mehler, & Segui (1989). Cutler, Mehler, Norris, and Segui (1986) comment that "what syllables lose [to phonemes] in terms of candidate set compactness, they may gain in terms of robustness with respect to the acoustic context" (p. 386). Segmentation of speech into phonemes is problematic since the acoustic information characterizing phonemes spreads across and depends on the neighboring phonemes, so that it may not be possible to identify a phoneme without reference to its context. Studies cited by Cutler et al. (e.g., Morais, Cary, Alegria, & Bertelson, 1979; Segui, Frauenfelder, & Mehler, 1981, both cited on p. 386) indicate that (a) young children show advantage in the identification of the number of syllables over the identification of the number of phonemes in a word tapping task; (b) illiterate adults' performance is strongly similar to that of preliterate children, suggesting that whereas phonemic competence may depend on alphabetic literacy, syllabic competence does not;

and (c) syllable-sized targets are segmented faster than phoneme-sized targets in the segmentation of continuous speech.

Rodrigues's (1994) study with BP speakers provided interesting data that can be considered evidence of a syllabic level of speech processing equally by illiterate, pre-literate, semi-literate, and literate subjects. Analysis of the results shows that the stimuli were processed according to the CV syllabic prototype pattern of the language. Of special interest, in this sense, is the data from pre-literates, semi-literates, and illiterates' segmentation of nonsense sequences into 'words'. CV syllabic processing is apparent both in the subjects' word boundary insertions and in occasional slips of the tongue.

A great deal of the discussion about the definition of the minimal unit of speech perception focuses on the existence of a basic universal unit or of language-specific units. Prompted by the assumption that "speech segmentation procedures may differ in speakers of different languages" (Cutler et al., 1986, p. 385) cross language studies have sought to explore the role of L1 perceptual units of analysis in L2 speakers' perceptual procedures.

Rodrigues (1994) comments that contrary to Mehler et al.'s (1981) hypothesis, which posited the syllable as the basic unit of analysis, regardless of the phonological characteristics of the languages, Cutler et al. (1986), Cutler and Norris (1988), and Cutler (1990) "emphasize the necessity of taking into account the precise phonological structure of the language in studies seeking to unveil the strategies employed in the speech segmentation process" (p. 40, author's translation from Portuguese). These studies demonstrate variable behavior in the segmentation of the speech chain according to language-specific patterns. In Cutler et al., for example, whereas French listeners showed evidence of syllabification when listening to native language stimuli, to English, and to nonsense words, English listeners showed no trace of such a

syllabification strategy in segmenting stimuli in the native language, nonsense words, and French. Other more restricted language specificities have led to investigations of the role of moraic perceptual analysis by Japanese speakers of English, for example (Cutler & Otake, 1994).

What is observed in these studies is the operation of procedures "appropriate for listening to input in the native language . . . applied to foreign-language input, irrespective of whether they remain appropriate" (Cutler & Otake, 1994, p. 824). However, the authors point out that it is important to consider the study of Cutler, Mehler, Norris, and Segui (1992) with adult French-English bilingual listeners to evaluate the extent of such interference. The subjects in this study showed native-like performance in both L2s, that is, ability to shift to the appropriate procedures according to the linguistic input. Cutler and Otake believe that L2 experience enabled these listeners to inhibit the L1 procedure when dealing with the L2 input.

In a replication of Cutler et al. (1986), Bradley et al. (1993) found that when dealing with English input, monolingual Spanish speakers' seemed to abandon the syllabification strategy employed with L1 input. Comparing these results to the ones obtained by Cutler et al. with French speakers, who showed evidence of syllabified representation both in L1 and L2, the authors speculate that the perception strategy employed might be determined not only by aspects inherent to the L1s, but also by the properties of the spoken inputs and the specificities of the perceptual 'occasions'. They cite the fact that Spanish has lexical stress as a possible critical difference from French, which may have accounted for the use of different L2 perceptual strategies.

As concluded by Bradley et al. (1993) and by other researchers working in the area of word recognition research (see a review in Frauenfelder & Kearns, 1997) much more research is needed to unravel the mysteries involved in the definition of the

functional unit of speech processing – research that goes from the investigation of task effects on sequence monitoring techniques used in word recognition studies to investigations of how and under what conditions phonemic and syllabic strategies operate.

Jenkins and Yeni-Komshian (1995) emphasize the role of cross-language research in contributing to the field. They consider that, by providing information about the specificities and universalities inherent in different phonological systems, cross-language research is crucial in determining the existence of a universal unit or language specific units of perception. The authors suggest that units at different levels may be involved in speech perception and production, "depending upon the stage of the listener and the particular L1-L2 relationship involved" (p. 464). On the one hand, for example, studies of VOT provide evidence for the role of the feature (voicing) as a unit of segmental analysis, whereas, on the other hand, phonetic training studies have provided evidence for an allophonic representation to be the unit of perceptual analysis.

Major (1994a) says that the relationship between the phonological underlying representation (UR) and the surface form is more straightforward in L1 acquisition than it seems to be in L2. In L1 phonological acquisition, the child's mental representation "is identical or nearly identical to that of the adult and ... the child's mispronunciations are due to processes causing deviations from the adult target rather than to perceptual inabilities" (p. 191). However, In L2 acquisition, he sees three possibilities: The UR may be (a) the same as the L2 native speakers; (b) the same of the speaker's L1; or (c) an intermediate representation. As in the case of the child who has an identical UR to that of the adults, an L2 UR identical to that of the native speakers does not guarantee native-like pronunciation because the speaker may be simply unable to produce it. In the two other cases, mispronunciation is likely to reflect the perceptual track, that is, the L2

phone is realized as the identical L1 or as the similar (a 'merger', in Flege's words) L1 phone.

4.5 The relationship between L2 perception and production

The relationship between L2 speech perception and production is posited in the SLM as follows:

> without accurate perceptual 'targets' to guide the sensorimotor learning of L2 sounds, production of the L2 sounds will be inaccurate. The model does *not* claim, however, that all L2 production errors are perceptually motivated . . . Still, a basic tenet of the model is that many L2 production errors have a perceptual basis. (Flege, 1995, p. 238)

Flege (1997, p. 81) adds that

> the view that production accuracy is limited by perceptual accuracy, does not mean, of course, that the ability to produce new sounds in an L2 is unrelated to articulatory complexity or linguistic markedness . . . an L2 learner might develop an accurate perceptual representation for sounds in the L2 without being able to accurately produce those sounds.

In hypothesis 7 of the SLM, the relationship between L2 perception and production is depicted as bound to change over time (see Section 4.3). According to the hypothesis, the production of an L2 sound will end up corresponding to the learner's phonetic category representation. In this sense, Baker and Trofimovich (2001) propose that developmental studies are essential for pinpointing mutations in the relationship. Flege (1999) states that although segmental perception and production may not reach perfect alignment as posited for L1, research has shown correlation between the two abilities for highly experienced L2 speakers, as predicted in the SLM.

The complexity of the relationship is acknowledged throughout the literature, and research attempting to unravel this complexity has provided inconclusive evidence pointing in three main directions. First, studies indicate that perception outperforms production (e.g., Archibald, 1993; Broselow & Park, 1995, both cited in Hancin-Bhatt, 1997, p. 111; Flege, 1984, 1988a; Flege & Hammond, 1982; Flege & Hillenbrand, 1984). Second, some studies show correlation between perception and production (e.g., Best, 1995; Flege, 1993, 1999; Flege et al., 1997; Flege et al., 1999; Flege & Schmidt, 1995; McAllister, Flege, & Piske, ms). Third, studies offer evidence that production may outperform perception (e.g., Flege-Eefting, 1987; Flege et al., 1997; Gass, 1984; Sheldon, 1985; Sheldon & Strange, 1982).

Research on the role of training in speech perception and production has, equally, yielded non-definitive results, triggering discussions along two main lines: (a) the effect of perceptual training on improvement of perception per se; and (b) the carryover effect of perceptual training to improvement in production.

Concerning the generalization effect of perceptual training, studies have yielded contradictory results. For example, on the one hand, McClaskey, Pisoni, and Carrel (1983) and Rochet and Chen (1992, both cited in Rochet, 1995, p. 396), showed evidence that training in one specific set of stimuli facilitated perception of other stimuli. On the other hand, Lisker (1970) and Strange (1972, both cited in Strange, 1995, p. 21), presented data showing that the effect of training was limited to the stimulus trained; that is, it did not extend to other stimuli. Strange (1995) comments that, in these studies, improvement seemed also to be restricted to the specific task used in the perceptual training procedures. Ambiguous data has also resulted from studies investigating whether perceptual training using synthetic stimuli facilitates perception of natural stimuli. In this sense, whereas Strange and Dittmann (1984) and Tees and

Werker (1984) presented negative results, Jamieson and Morosan (1986), McClaskey, Pisoni, and Carrel (1983), Pisoni, Aslin, Perey, Hennessy (1982), and Rochet (1995) showed positive results.

Studies investigating the carryover effect of training on perception to production are very limited, as remarked by Rochet (1995). In Rochet and Chen (1992, cited in Rochet, 1995, p. 396) the results suggested a positive transfer.

Besides being an essential pursuit for L2 researchers concerned with the pedagogical aspects that the question involves, investigations of the effect of perceptual training on production performance may contribute to elucidating the theoretical complexities of the relationship between speech perception and production.

Returning to the three hypotheses posited for the relationship, Wode (1995) claims that because perceiving the sound patterns of an L2 is a requisite for learning the language, both common sense and linguistic expertise argue for the prediction that perception precedes production. Corroborating this claim, Baker and Trofimovich (2001) say that

> the most widely accepted hypothesis is that accurate perception is at least one necessary component of accurate production . . . . [This] translates into perception abilities usually surpassing, and therefore preceding production abilities, especially for beginning second-language learners. Even advanced language learners, whose perception and production abilities are nearly asymptotic, perceive some vowels more accurately than they produce them. (p. 273)

In fact, Flege (1999, and elsewhere) emphasizes that the correlations identified in the perception and production performance of highly experienced L2 speakers are in general significant, however, not more than 'modest' (average correlation $r = 0.50$.) in a number of studies examining the relationship at the level of segments (consonants and vowels) and of global foreign accent. For example, he cites the segmental investigations carried out by (a) Flege (1993), examining the perception and production of vowel

duration cues to the voicing distinction in English word final /d/ and /t/ by two groups of native Chinese speakers – early and late L2 English speakers; (b) Flege and Schmidt (1995), and Schmidt and Flege (1995), investigating the perception and production of VOT in word-initial English stops of Spanish 'proficient' and 'non-proficient' (proficiency determined by overall degree of foreign accent) speakers of L2 English; (c) Flege et al. (1997) examining the performance of German, Spanish, Mandarin, and Korean late speakers of English concerning English vowels; and (d) Flege et al. (1999), investigating perception and production of English vowels by three groups of native Italian speakers – early (AOA-7yrs), mid (AOA-14yrs), and late L2 speakers (AOA-19yrs).

'Relations at higher levels' were examined in Flege (1988a) and Meador, Flege, and MacKay (2000), which dealt with the relationship between perception and production at the level of global foreign accent. The former examined groups of Chinese speakers who had lived in the US for averages of 1.5 and 5.3 years, and spoke English with strong foreign accent, gauging degree of foreign accent in English sentences, and producing English sentences. The latter established correlations between native Italian speakers' segmental perception, word recognition and overall pronunciation performance.

Flege (1999) raises some possible explanations for the fact that perception-production correlations in these studies, although significant, were only 'modest', and his comments can be extended to speculate on reasons for the (apparent) inconsistencies and contradictory outcomes in the whole repertory of research on the relationship between speech perception and production. Detailed analysis of the research indicates that, although it undoubtedly constitutes an outstanding body of data, it presents limited generalizability in face of the diversity of methodological factors employed in different research programs. Therefore, comparison between results pointing to one or the other

nature for the relationship must take into account such diversity in order to avoid superficial or misleading interpretations. For example, the author mentions three interesting potential sources of problems that may help to explain why the correlations in the studies described above have not been higher. First, since phonetic contrasts between segments occur on "multiple dimensions that enter into 'trading' relations" (p. 3), the results of segmental studies focusing on a single phonetic dimension, such as VOT, may overlook other dimensions that are liable to change concurrently in both perception and production, and the correlation between the abilities may be underestimated. Flege (1999) argues that the reason why McAllister et al. (ms) found a stronger correlation (than in any previous study on the matter) may have been the fact that "more nearly commensurable" variables were investigated in this study. Second, L2 research may not be assessing "the most meaningful perceptual variable" (p. 4) – category formation – which according to the SLM strongly affects production of L2 segments, as shown in Flege, Schmidt, and Wharton (1995). To account for this shortcoming, Flege suggests the use of category formation tests accompanying tests at the segmental level focusing on specific dimensions such as VOT. Third, whereas there is generally concern with speech style (word lists vs. free speech, for example) in production tests, in perceptual testing this factor is not usually considered. Therefore, the lack of uniformity between the stimuli of production and perception tests, in terms of "degree of clarity of the speech samples used (or carefulness) as well as speaking rate" (p. 3) has not been given the necessary attention.

The lack of consensus in studies investigating speech perception and production separately and in interrelation is also attributed to individual differences, that is, the widely recognized subject variability related to the effect of psychosocial constraints on L2 acquisition and learning. Strong inter-subject variability was identified in Baker and

Trofimovich (2001), Beddor and Strange (1982), Bradlow, Pisoni, Akahane-Tamada, and Tohkura (1997), Flege, Frieda, Walley and Randaza (1998), and Riney and Flege (1998), among other studies focusing on L2 speech perception and production.

Speculations about the reasons for such variability led Baker and Trofimovich to investigate the effect of self-perception as a factor contributing to lack of uniformity in intermediate subjects' perception performance, an effect for which considerable evidence has been found in L1 research. Although the limited number of subjects investigated (four intermediate subjects) allows for little more than speculation, the results suggest that there must be grounds to suspect that self-perception plays an important role in L2 as well, since those subjects presenting production scores superior to perception were the ones who showed better self-perception. Undoubtedly, Baker and Trofimovich's study poses one more challenge to the field.

A further variable pointed out as capable of leading to mistaken interpretations of results as coincidental or controversial is the task variable. For example, Logan and Pruitt (1995) observe that Strange and Dittman (1984) used one type of task to train perception of synthesized material and another to test generalization to natural settings. Flege et al. (1999) suggest that differences between testing procedures (and/or stimuli) may be the cause of apparent differences in the outcomes of previous studies investigating early bilinguals' perception of L2 vowels and the outcomes of their own study, which showed performance at native level.

The lack of consistency in experimental designs seems to be mainly due to the recentness of research on L2 speech perception, and consequently, of research on the relationship between perception and production, both of which have intensified only in the last two decades. Beddor and Gottfried (1995) remark that owing to the short history of L2 speech perception research in comparison to L1 research, whose first publications

date from the early 1970s, some procedures widely used in L1 perception assessment have not been tested in L2 research. In fact, the recentness of L2 speech perception research means that not only the variables under investigation are tested in the experiments, but also that the appropriateness and comparability of methodological variables involved, such as the material and the testing procedures themselves, are subject to evaluation.

4.6 L2 speech perception assessment

Adult L2 speech perception assessment has been carried out most frequently through variations of two types of criterial tasks – identification (or labeling) and discrimination (or differentiation), and a few studies have used imitation tasks (e.g., Diehl, McCusker, & Chapman, 1981; Flege & Hammond, 1982; Rochet, 1995, all cited in Beddor & Gottfried, 1995, p. 221).

In identification tasks the stimulus are presented one at a time or in a continuum. The listeners' task consists of selecting a response corresponding to each stimulus from a number of alternatives given time (Polka, Jusczyk, & Rvachew, 1995, p. 75). Some of the most frequently used identification tests, such as labeling, two-alternative-forced-choice (2AFC), and continuum partitioning, are briefly reviewed by Flege (ms). The labeling techniques – whether using orthographic labels, phonetic symbols, or keywords – are particularly criticized for being strongly vulnerable to listeners' familiarity with the labels themselves. In this sense, Beddor and Gottfried (1995) point out that in cross-language situations, besides the L2 difficulties, labeling involves the additional burden of the ability to deal with the L2 labels, where the L1 orthographic system *per se* may

affect the interpretation of these labels and, consequently, bias the responses. The fact that identification procedures involve a limited set of response alternatives is seen as positive in that it imposes a lighter load on memory, and in that it allows for applying bias-free estimates of perceptual sensitivity. However, by imposing a limited set of alternatives, the task might disregard listeners' ability to make further identifications not only in terms of other possibilities within a specific categorial parameter but also in terms of other "perceptually relevant categories of response" (p.223). One further problem with cross-language identification tests is the interpretation of the outcomes. The procedure involves concomitant performance in two tasks: recognition of stimuli differences and assignment of appropriate labels. Unless responses are highly consistent, it is not possible to determine whether success or failure in labeling is due to appropriate or inappropriate performance in one task or the other, or in both (Polka, 1992). Beddor and Gottfried (1995, p. 223) propose that variations of the identification technique, such as the category goodness judgment, employed in Bohn and Flege (1990), Gottfried and Beddor (1988), Miller and Volaitis (1989), and Kuhl (1991), and reaction-time measurements, as employed in Logan, Lively, and Pisoni (1991), Pisoni and Tash (1974), and Werker and Logan (1985), by incorporating a larger number of categories and allowing for within-category comparisons, might be useful in assessing perceptual performance.

Discrimination techniques involve "the presentation of multiple (usually three) stimuli per trial" (Flege, ms, p. 3), where the listeners' task is to differentiate two stimuli. Beddor and Gottfried (1995, p. 224) review the main tendencies of earlier and more recent discrimination test formats employed in cross-language speech perception experiments. Earlier studies used three types of tasks: (a) the 'oddity' discrimination, presenting three stimuli, one of which acoustically different from the other two; (b) the

ABX task, in which A and B differ physically and X is identical to either A or B; and (c) the same-different AX (or 2IAX) procedure, presenting two acoustically identical or different stimuli. The authors point out that disadvantages of these discrimination tests are (a) in oddity discrimination tests it is impossible to estimate unbiased perceptual sensitivity; (b) in ABX tests the distance between A and X may impose an additional load on memory and the test may be performed as a simple-different BX task, where A works only in diminishing uncertainty; and (c) in AX tests listeners may be biased to answer "'same' when the discrimination is difficult" (p. 224).

More recent tendencies indicated by Beddor and Gottfried are the 4IAX and the AXB formats. In the first, listeners indicate which of the two pairs presented contains the difference. The second type involves two acoustically different tokens – A and B – and the variable stimulus is presented between them.

Reservations about standard techniques have encouraged procedural modifications in the direction of minimizing the effect of potential sources of response bias. Beddor and Gottfried (1995) state that changes in speech perception assessment methods have occurred along with innovative theoretical questions that have been motivating research more recently. It appears that the development of most recent versions of discrimination tests seems to stem from a shift of focus of interest from L2 listeners' ability to discriminate stimuli within one specific category to their ability to formulate categories appropriately making use of or ignoring physical variations among various speech stimuli.

Within this last tendency, a categorical discrimination test (CDT) was designed by Flege and co-workers (see Flege, ms; Flege et al., 1999; Flege, Munro, & Fox, 1994 for descriptions). The test pursues the modern tendencies by requiring listeners to categorize the stimuli without using labels and ignoring acoustic variations. The

variable stimulus (the odd item out) can occur in any position of the trial. Flege remarks that this type of test increases difficulty, accounting for the criticism that estimates of perceptual sensitivity in oddity tests may be highly biased by the limited number of alternatives in the test or by the position of the odd item in the sequence. The perception test adopted in the present research was designed according to the main norms of Flege's CDT.

Flege (ms) points out that one innovation of the modified version of the oddity format test designed for his experiments was the addition of *catch trials* to the original *different trials*. Different trials are those containing an odd item out, whereas catch trials do not contain an odd item out. As in the different trials, in the catch trials each stimulus is spoken by a different talker, however, in the latter, the same token is repeated, so that what is presented to the listeners is three physically different realizations of the same token. Catch trials are included to encourage listeners to disregard phonetically irrelevant differences in the stimuli, and they are not used in the analyses. The dependent variable in the data analysis is the A' score, "an analog of d' from the Theory of Signal Detection (see Snodgrass, Levy-Berger, & Haydon, 1985) that does not require a large number of responses" (Flege, ms, p. 5). The A' scores, in the CDT, are calculated from the proportion of times that subjects choose the odd item out correctly in different trials (HIT) and the proportion of times they choose an odd item out in catch trials, where the correct response must be 'none' (false alarms – FA). Flege says that the A' score has the advantage (over simple percent correct discrimination scores) of diminishing guessing rate and providing unbiased measures of perceptual sensitivity. In AXB and ABX formats, in which one of two responses, A or B is correct, a guessing rate of 50% can undermine the test's sensitivity. The listeners' task in the CDT is to circle '1', '2', '3', or 'none', on an answer sheet, according to whether the odd item out

is in the first, second, third position or there is no odd item out in the trial presented.

A third type of speech perception task has been used in cross language research with less frequency, though – the imitation task. As advantages of the imitation procedure, Beddor and Gottfried (1995) cite the fact that it does not include labeling, it reduces memory load, and elicits speech in a relatively natural way. However, it is emphasized that imitation tasks do not provide unequivocal evidence of perceptual ability because they "combine (and confound) an assessment of perceptual and articulatory ability"(p. 221).

Determining which tests are best suited for the perceptual situation under examination is crucial, since different types of tests answer different questions. The effect of experimental manipulations, that is, of the measurement instrument and testing procedures, on the linguistic outcome expected and/or observed in speech performance experiments is a source of frequent debate in the literature. The difficulty, and sometimes, the impossibility of gathering natural language samples, leads experimenters to devise manipulated elicitation tasks to control for the specific phenomena under investigation. As stated in Labov's Observer's Paradox (Ellis, 1986), despite the artificial character that language performance obtained from structured elicitation may have, gathering data from truly spontaneous speech may not only be difficult, but also fail to provide sufficient amounts of relevant language for analysis. The complexity of the matter assumes greater proportions in perception assessment. Since it is impossible to access data in natural contexts, experimenters have to be strictly careful to devise laboratory techniques capable of detecting perceptual behavior neutrally, that is, techniques that are undoubtedly capable of neutralizing test artifacts.

4.7 Conclusion

This chapter addressed the issue of age-related constraints on L2 pronunciation acquisition, traditionally posited in terms of the CPH. It reported on research within the framework of the SLM, which has opened new avenues concerning the influence of age on speech acquisition/learning, showing that, on the one hand, early L2 learners may perform poorly, and, on the other hand, late learners may achieve native-like pronunciation patterns. early and late L2 learners are characterized in this research by contact with the language before or after onset of reading, when L1 speech sounds are systematized. In this view, adults' diminished ability to acquire L2 sounds occurs as a function of the stabilization of L1 parameters that operate as a grid/sieve/filter in the perception and production of L2 sounds, and is responsible for foreign accent. Accented performance is viewed not only in terms of speech production, but also, with relation to its perceptual component – the *perceptual foreign accent*. The difficulty in isolating age as the only variable operating on such behavior in experiments carried out by the SLM researchers is related to two main variables – amount of L2 experience and degree of use of the L1, since this research has been conducted mostly in L2 environments. The influence of other psychosocial variables is also acknowledged by authors.

The SLM was described in the third section of this chapter with attention to aspects pertinent to the present investigation, such as the early formation of categories for L1 speech, their influence on L2 acquisition/learning by the process of equivalence classification, the lack of definition of the criteria employed in such categorization, and consequently, interlingual associations.

The chapter then focused on the question of the definition of the unit of speech perception, the form of the underlying representation of the speech signal. The SLM has

been construed on the segmental level of speech (phoneme-sized units) and has spawned research data on the same dimension. The internal representations of the speech signal at this level are characterized as VOT and formant values, for stops and vowels, respectively. This study deals with syllable structure and the presence or absence of an additional phone in the perception and production of L2 word-final consonants. The chapter reports on discussions on the role of the syllable as the unit of speech perception at this level.

The fifth section presented a brief report of research on the relationship between L2 speech perception and production of the last decades, and finally, the last section described the speech perception assessment procedures most frequently employed in recent L2 research, describing the general framework of the perception test used in this study, the CDT.

Most of the empirical findings reported and briefly reviewed here are described in an outstanding publication of 1995 – *Speech Perception and Linguistic Experience: Issues in Cross-Language Research* – a publication that put together work of some of the most influential names in the field of speech perception research. Although a wealth of empirical data had already been gathered at the time, authors were unanimous in emphasizing that speech perception was a flourishing area of research. Undoubtedly, the upsurge of sophisticated technologies in the last decade has provided opportunity for questioning old truths concerning psycho-cognitive issues involved in the acquisition and development of speech perception and production. Research on new questionings and research reassessing earlier studies will surely profit from these technological improvements, of the multiplication of bilingual communities enhanced by temporary or permanent migration opportunities of the modern times, and of the consequent search for improvement in L2 language pedagogy. Such research will make it possible to

reaffirm or disaffirm the currently stated outcomes and to answer questions left open by previous investigations.

CHAPTER 5

METHOD

5.1 Introduction

The experiment described in this section was carried out to address the research questions and hypotheses stated below. The data was collected in Brazil, in the second semester of 2000, in the foreign language laboratories of two universities. The speech production data was, afterwards, treated and rated by native speakers of English in the Speech and Hearing Laboratory at the University of Alabama at Birmingham – UAB. This chapter describes the participants, the data collection instruments, the procedures adopted in the experiment, the preparation of the speech production data for native speaker judgements, the criteria and procedures employed in these judgements, the criteria and method of data analysis, and the statistical treatment employed.

5.2 Research questions and hypotheses

Three main questions stem from the theoretical and scientific rationale described in the previous chapters. According to the objectives of this dissertation stated in Section 1.2, two of these questions aim at re-examining outcomes of Baptista and Silva Filho (1997), and a third one focuses on the relationship of speech perception and production. Precisely, these three broad questions can be expressed in the following way: (a) to what extent does markedness of the target consonant influence perception and production of word-final vowel epenthesis by BP speakers of English?; (b) to what extent does

phonological environment influence perception and production?; and (c) is there a relationship between epenthesis production in word-final consonant codas and the discrimination of ##CVC## and ##CVCV## sequences where the final vowel is an /i/?

As in Baptista and Silva Filho's study, markedness relations are studied here based on Eckman's (1987a) MDH (see Section 3.2.1), according to which, the more marked the English final consonant, the more difficult its production by BP learners is expected to be; and phonological environment is studied based on Carlisle's work (1991a, 1991b, 1992, 1997, 2001), Hooper (1976) and Murray and Vennemann (1983), as specified below. The relationship between perception and production is studied based on Flege's (1995) SLM (see Section 4.3).

Each of the three main questions above includes more specific ones, which relate to the research hypotheses put forward in this dissertation in the following way:

Question 1: Does markedness in terms of voicing of the target consonant influence epenthesis production?

Hypothesis 1: Voiced consonants cause more epenthesis than their voiceless counterparts.

Background: Eckman's (1977/1987a) MDH.

Question 2: Does markedness within the class of obstruents influence epenthesis production?

Hypothesis 2: Affricates cause more epenthesis than fricatives, which cause more epenthesis than stops.

Background: Eckman and Iverson (1994).

Question 3: Does markedness in terms of place of articulation of the target consonant influence epenthesis production?

Hypothesis 3: The voiced velar causes more epenthesis than the voiced alveolar, which causes more epenthesis than the voiced bilabial.

Background: Yavas, 1994, 1997.

Question 4: Does phonological environment in terms of vowels, consonants and pauses influence epenthesis production?

Hypothesis 4: Consonants in the context cause more epenthesis than vowels, which in turn, cause more epenthesis than pauses.

Background: Carlisle, 1991a, 1991b, 1992, 1997, 2001.

Question 5: Do strength relations across syllables influence epenthesis?

Hypothesis 5: The greater the difference in consonantal strength between the target and the context consonant the greater will be the frequency of occurrence of epenthesis.

Background: Hooper (1976), and Murray and Vennemann (1983).

Question 6: Is there a correlation between discrimination of ##CVC## and ##CVCV## sequences where the final vowel is an /i/, and epenthesis production in word-final consonant codas?

Hypothesis 6: Subjects who produce more epenthesis fail more frequently to discriminate ##CVC## and ##CVCV## sequences where the final vowel is an /i/.

Background: Flege (1995)

Question 7: Does markedness in terms of voicing of the target consonant influence discrimination of ##CVC## and ##CVCV## sequences where the final vowel is an /i/?

Hypothesis 7: Subjects discriminate more ##CVC## and ##CVCV## sequences where the target consonant is voiceless than where it is voiced.

Background: Flege (1995), and Eckman's (1977/1987a) MDH – related to hypothesis 1 above.

Question 8: Do strength relations across syllables influence discrimination of ##CVC## and ##CVCV## sequences where the final vowel is an /i/?

Hypothesis 8: Subjects discriminate more ##CVC## and ##CVCV## sequences where the difference in consonantal strength between the target and the context is smaller.

Background: Flege (1995), Hooper (1976), Murray and Vennemann (1983) – related to hypothesis 5 above.

5.3 Participants

Seventy-one Brazilian students were tested: 48 females and 23 males, ranging in age from 17 to 46 years. All students were from the first and second semesters of English undergraduate courses at three universities – *Universidade Federal de Santa Catarina (UFSC)*, *Unidade Catarinense de Ensino Superior (UNICA)*, and *Fundação Barddal de Educação e Cultura – Faculdade de Letras (BARDDAL)*. From these students, a group was selected according to pre-established criteria using a profile questionnaire. The set of criteria aimed at selecting a group of adult learners pedagogically characterized as 'false beginners', that is, learners who have a strictly limited ability of comprehension and functional use of the language, in general owing to little or discontinued training. Thus, all students selected shared the following characteristics: (a) previous experience with

English as a foreign language in high schools, where the instruction was centered on reading and writing skills; (b) from 8 to 12 months of continued instruction at private language schools and/or at the university they were attending; and (c) little (up to one month) or no experience in an English speaking country. Besides being 'false beginners' in English, the students selected were not fluent in any other foreign language and were as young as possible: from 17 to 25 years of age. A group of 48 students meeting these criteria were selected from the original 71. Subsequently, 14 students were excluded from the selected group in a monitoring procedure for recording quality assurance: their recordings contained extraneous noise that could not be neutralized in the digitizing procedure. From the remaining 34 students the recordings of 20 (13 female, 7 male), ages between 17 to 23 (mean=20years) were randomly selected to serve as data for this investigation (Appendix A).

The limitation to 20 participants was necessary to guarantee the effectiveness of the speech production judgement procedures to be performed by native speakers (see Section 5.6). It would be impractical to conduct these judgements with a larger group of participants because the huge number of speech samples to be rated would imply innumerable or extremely long sessions. Besides these 20 Brazilian students, four native speakers of English served as control in different tests – one in the sentence reading test and three in the speech perception test.

5.4 Materials

The data gathering instruments designed for the investigation comprised a participants' background questionnaire and three tests – two of speech production and

one of speech perception. The speech production tests were a sentence reading test and a 'free' speech test divided in two tasks – a directed speech task, and a story re-telling task. It was necessary to use two tasks in order to try to elicit as many C## productions as possible. Although the question of task-type effects on speech production was not one of the main concerns of this study, it was reasoned that it would be interesting to add some data gathered without orthographic stimuli to provide some insight into the discussion.

The speech perception test was an oddity discrimination test. The audio stimuli and the participants' responses in the recording tasks were recorded on individual magnetic tapes.

5.4.1 Questionnaire

A questionnaire (Appendix B) was administered to assess biographical information, such as age, sex, and L1 regional accent, and information about factors emphasized in the literature as relevant to L2 pronunciation, including age of onset of L2 instruction, amount of instruction and language skills explored, overall amount of L2 input and use, and contact with other foreign languages.

5.4.2 Sentence reading test

The sentence reading test consisted of 456 sentences specially designed to ensure that the relevant phonological environments were included in the corpus (Appendix C).

Fifty-eight of these sentences were copied or adapted with permission from Silva Filhos's (1998) corpus. The sentences were checked for content by two native speakers of English. Each sentence contained a monosyllabic (C)CVC target word followed by a monosyllabic CVC(C)(C) or VC(C) context word or by a pause. The sentences were checked for content by two native speakers of English. Each sentence contained a monosyllabic (C)CVC target word followed by a monosyllabic CVC(C)(C) or VC(C) context word or by a pause. For example, the sequences 'wet pad', 'Biff sails', and 'brave soul', were included in sentences designed for the target-context sequences /t-p/, /f-s/, and /v-s/. The sentences varied in length from five to seven words, and, owing to the students' beginning level of English, an effort was made to limit them to the lexicon characteristic of basic course text books. Two control measures were adopted to avoid a chain-effect in epenthesis production: (a) the CCVC target words contained no /s/-clusters, and (b) before the target word in the sentence, there was no word beginning in an /s/-cluster, or ending in a consonant cluster, or in a single consonant not allowed in final position in Portuguese. The great majority of words before the target ended in vowels, there were just a few cases where words preceding the target word ended in one of the four final consonants allowed in Portuguese (/n/, /l/, /r/, /s/). which are not expected to trigger epenthesis (see Section 2.4.2).

The target consonants originally included were: /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /s/, /z/, /ʃ/, /tʃ/, /dʒ/, /m/, and /n/. The consonants /θ/, /ð/, /r/ /l/, /ŋ/, and /ʒ/ were not included because they are infrequent in final position or because they cause other types of pronunciation problems: (a) Besides not being frequent in final position, /θ/ and /ð/ are quite frequently pronounced as the stops /t/, and /d/, or the fricatives /s/, /z/, and /f/ (Xavier, 1989); (b) the final /r/ is frequently pronounced according to the speaker's

dialect in BP: as a flap [ɾ], the velar fricative [x]or [ɣ], the trill [r̆], or the retroflex [ɹ] (see Section 2.4.2 for the possible final consonants in BP); (c) the final /l/, also as in the native language, is in general glided to [ʊ̯]; (d) the /ŋ/ is often pronounced as a nasal vowel followed by [g], frequently with vowel epenthesis; and (e) the fricative /ʒ/ was not considered because it is very infrequent in final position.

Data concerning /s/, /z/, /m/, and /n/ were collected with two types of target words: those spelled with a final consonant and those spelled with the consonant followed by 'e'. Brazilian learners tend to pronounce these four final consonants, when not followed by 'e' in English words, in the same manner as they pronounce them in the native language (again, see Section 2.4.2): (a) For the nasals (both /m/ and /n/) the preceding vowel assimilates the nasal feature and the nasal consonant is deleted; (b) for the sibilants, dialect and phonological environment determine their realization as /s/, /ʃ/ or /z/, /ʒ/. However, when the consonant is followed by 'e', the word is in general pronounced by Brazilian learners with vowel epenthesis, the consonant becoming syllable-initial. Results of Baptista and Silva Filho (1997) seem to indicate that orthography plays a role in such cases.

Each of the 19 targets (15 target final consonants plus 4 consonants followed by 'e') appeared in 24 sentences. In each of the sentences the target word was followed by (a) a context word beginning with one of the 19 consonants /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /s/, /ʃ/, /tʃ/, /dʒ/, /m/, /n/, /θ/, /ð/, /r/, /l/, and /h/; (b) a context word beginning with the semi-vowel /w/; (c) a context word beginning with one vowel from each of the three 'pairs' /ɛ-æ/, /ɑ-ʌ/, and /ɔ-oʊ/; or (d) a pause, i.e., at the end of the sentence. The glide /j/ was not included in the contexts because it is in general pronounced by Brazilian

learners as [i], or [ɪ]. The limitation in terms of vowels was due to the fact that it was not the objective of this study to investigate vowel quality differences, but only to contrast the effect of vowels and consonants as phonological environments in which epenthesis production occurs.

The 456 sentences were randomized for presentation so that each participant received a different order. The lists were typewritten on A4 paper, in "Arial, 14, black" format with double spacing.

The set of materials for the test consisted of written instructions in Portuguese, two blocks of nine sheets each, containing the typewritten sentences, an audio-tape for the recording, and a card (Appendix D).

5.4.3 Free speech test

5.4.3.1 Directed speech task

The elicitation device for the directed speech task was a written outline, in Portuguese, containing guidelines for the talk (Appendix E). It instructed participants to talk freely for 1 min about any subject of their choice or just give information about themselves using the outline provided to help them with the task.

5.4.3.2 Story Re-telling task

The material for the story re-telling task was a shortened adaptation of *The Cat in*

the Hat (Dr. Seuss, 1957) recorded by an adult, female, native speaker of American English. This story was selected because it contains short rhymed sentences with a large number of monosyllabic words ending in a single consonant. The rhyming was considered important both to enhance the recalling of the story, and, since it was concentrated on the (C)CVC words, to favor the production of these words.

This adapted version contained 37 sentences and 13 illustrations matching sets of events (Appendix F). Overhead projector transparencies and handouts with the illustrations were used in order to help participants to recall the story.

The set of materials consisted of written instructions in Portuguese, the handouts with illustrations, and an audio-tape with the stimuli (Appendix G).

5.4.4 Oddity discrimination test

An oddity format test was used to determine if subjects could discriminate ##CVC## from ##CVCV## sequences where the final vowel was an /i/. The test followed the design and procedures of the Categorial Discrimination Test (CDT) designed by James E. Flege to assess subjects' ability to perceive English vowels categorically (see Flege et al., 1994; and Flege et al., 1999). It consisted of 72 trials of 3 two-word phrases formed by a proper name or nickname and a verb in the present tense (e.g., *Dave bites/ Dave bites/ Davie bites; Bobby needs/ Bob needs/ Bob needs*) (Appendix H). It was necessary to make up some names and nicknames in order to include all the intended contrasts. Familiar names and nicknames such as names of famous people and loan names were not included, since a pilot study

indicated that familiarity with the orthographic form of the names could interfere with the results.

The target proper names or nicknames were either a (C)CVC or a (C)CVCV word where the last C was one of the 15 consonants: /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /s/, /z/, /ʃ/, /tʃ/, /dʒ/, /m/, /n/. The verbs – (C)VC(C)(C) words – provided the 24 different contexts: the consonants /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /s/, /ʃ/, /tʃ/, /dʒ/, /m/, /n/, /θ/, /ð/, /r/, /l/, /h/, the glide /w/, and the vowels /ɛ/, /æ/, /ɑ/, /oʊ/. In order to maintain the pattern of the phrases, pauses were not included as contexts.

Three types of trials were designed: (a) "different" trials – trials containing an odd item out (i.e., different from the other two) in the form of the contrast studied ((C)CVC or (C)CVCV target words); (b) "catch" trials –where there was no odd item out, i.e., all three stimuli consisted of the same phrase; and (c) "distractor" trials – where the odd item out appeared in the form of a contrast in the vowels or consonants of the verbs (e.g., *Cat bands/ Cat bends/ Cat bends; Cat seals/ Cat zeals/ Cat seals; Catty backs/ Catty bags/ Catty bags*), rather than the contrast in the noun in the different trials. Three female native speakers of English recorded the stimuli. In all trials each phrase in the sequence of three was spoken by a different talker. In line with the test developed by Flege, catch trials were included to "encourage subjects to respond to phonetically relevant differences, not to *any auditorily detectable* difference between the stimuli" (Flege, ms, p. 5). Although not present in Flege's original CDT design, which dealt with individual vowels, the inclusion of distractor trials was necessary here to diverte participants' attention from the objective of the test, and thus avoid biased results.

The total of 72 trials comprised 36 different trials, 24 distractor trials, and 12 catch trials. In the different and distractor trials, an odd item appeared in one of the three

positions in the trial and thus the correct answer would be "1", "2", or "3". In the catch trials, there was no odd item, so the correct answer would be '0'. The quantification of these trials depended on the counterbalancing of a number of variables: (a) the structure of the odd item (either a (C)CVC or a (C)CVCV word); (b) the position of the right answer in the answer sheet – either in the second, third, or fourth columns when there was an odd item, or in the first, when the answer was 'no odd item'; (c) voicing of targets and contexts; and (d) syllable contact numbers – SCN (see Section 3.3) (Appendix I).

After these variables were carefully counterbalanced in the definition of the number of different trials, the number of catch and distractor trials was determined accordingly. Since in the different trials the correct answer (the odd item out) appeared 12 times in each position on the answer sheet, the number of catch trials was set at 12 as well, so that the right answer for target-contrast trials occurred in the first, second, third, and fourth position an equal number of times. The number of distractor trials was set at 24 in order to have a consistent number of non-target trials, distracting the attention from the objective of the test as much as possible. In these trials the right answer was evenly distributed among the three serial positions ("1", "2", and "3") as well. Together, catch trials and distractor trials corresponded to half of the test.

The audio-stimuli were recorded in a sound treated room, using ProTools 24 hardware and Sound Forge software with 16-bit resolution at a 44.1-kHz sampling rate. The audio-signal followed a path from a condenser microphone (Audio-Technica AT4033a), through an amplifier (dbx 286) to a ProTools 24 table (MACKIE 1604VLZ). The stimuli were low-pass filtered at 4.8 kHz and normalized for peak intensity. The three talkers were recorded in individual sessions. In order to minimize intonation interference, talkers read sequences of five phrases and the first and last phrases, which

were equal to the second and the fourth phrases, respectively, were later edited out. The material was digitally edited and the inter-trial interval set at 2.8 s and the inter-stimulus interval at 1.3 s following Flege (ms). The talkers' voices were randomly distributed in the three positions within each trial. The stimuli were then transferred to a magnetic cassette using a tape deck Denon Model DN-720R.

A training sequence of 12 trials was also prepared. It had four different trials, three catch trials, and five distractor trials (Appendix J).

The set of material for the test consisted of an instruction/answer sheet for the training session, an instruction sheet for the test session, an answer grid, and an audio-tape containing the stimuli (Appendix K).

5.5 Procedures

One week before running the experiment the researcher talked to each group and the teachers who had agreed to recruit their students, explaining the overall procedures; however, details about the purpose of the study were not given. The participants were told only that the study aimed at gathering data about the oral performance of adult beginners, and that they were going to be required to perform listening and speaking tasks similar to those practiced in their English classes.

Participants were tested in three groups of approximately twenty-five. Students from the *Universidade Federal de Santa Catarina (UFSC)* and from the *Fundação Barddal de Educação e Cultura – Faculdade de Letras (BARDDAL)* were tested in the foreign language laboratory of the former and the students from the *Unidade Catarinense de Ensino Superior (UNICA)* were tested at the laboratory of this

university. The sessions were held during the time of their normal English classes, by the researcher and one assistant.

The laboratory at *UFSC* is equipped with two consoles (Sony model LLC4500MKII), with tape recorders (Sony model ER4041) for the instructor, 32 cassette tape recorders (Sony model ER5030), and head-mounted microphones (Sony model HS95). The laboratory at *UNICA* is equipped with one console with a tape recorder for the instructor, and 25 cassette tape recorders and head-mounted microphones (CE model Tanderberg Educational System 200).

Exactly the same procedures were followed in terms of sequence and timing of testing and breaks. The session took approximately 1 hr 50 min, divided into three parts with two short breaks as follows: (a) questionnaire – 10 min, (b) sentence reading test – 35 min, (c) break of 5 min, (d) directed speech task– 10 min, (e) oddity discrimination test – 30 min, (f) break of 10 min, and (g) story re-telling task – 10 min.

A short portion of the recordings was played preceding the running of the oddity discrimination test and the story re-telling task to enable participants to adjust the volume of the headphones to a comfortable level. Oral, written instructions, or both were given in Portuguese before each test.

5.5.1 Questionnaire

Before the testing, participants received the written questionnaire in Portuguese, answered the questions and handed them in to the researcher.

5.5.2 Sentence reading test

Each participant received an envelope containing written instructions in Portuguese for the test, two blocks containing the typewritten sentences, an audio-tape, and a card. The 18 sheets containing the 456 typewritten sentences were divided into two blocks of nine in order to make the turning of pages easier. Also, owing to the length of the material it was considered that the short interval imposed by putting the first block aside and picking up the second would be psychologically effective.

Following the instructions, participants wrote their names on the envelope[13] and on the tape tag, and were given practice in dealing with the recording and hearing equipment. After it was made sure that there was no doubt about the procedures, the reading-recording task started. Although reading was self-paced, a patterned rhythm was guaranteed by the use of the card to cover the sentences, being slid down as the reading proceeded. The use of the card was also intended to prevent visual preparation for reading the next sentence, and the inadvertent skipping of any sentence.

Participants were instructed to record each sentence once. After the recording of the first set of sentences, the block was put back in the envelope and the reading of the second block was recorded. At the end of the task, participants were asked to fast-forward the tapes to the end and turn them to the other side to prepare them for the following recording task. Then they were allowed to leave the room for a 5-minute break.

One native speaker served as control in this test. The subject was recorded in the language laboratory at *UFSC* during the time that another foreign language class was occupying it, so that the recording had similar conditions to those of the nonnative participants in terms of background noise.

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[13] Numerical codes were assigned to the participants to protect their identity.

5.5.3 Free speech test

5.5.3.1 Directed speech task

Participants received the written and oral instructions in Portuguese and were encouraged to ask vocabulary questions and interact with colleagues for 1 min. Production was cued by the written list of items that could be included in the talks. They were allowed to silently rehearse during 1 min, but no writing was permitted. They were asked to speak as much as possible during 1 min, even if they could only produce isolated words. The start and stop commands for the recordings were given by the researcher.

5.5.3.2 Story re-telling task

Oral instructions were given in Portuguese, emphasizing that the task did not aim at testing memory capacity, but rather oral performance as in the previous speech production tasks. As in the directed speech task, participants were encouraged to produce isolated words if they could not make up sentences. The stimulus tape was played to the participants through headphones and the illustrations projected one at a time, following the story events, via an overhead projector. The entire presentation was repeated three times, after which participants received a sheet of paper with the illustrations and were allowed 1 min to silently prepare their retellings of the story. No writing was permitted. The subsequent 1 min recording time was controlled by the researcher.

5.5.4 Oddity discrimination test

Participants were given written and oral instructions for the test. They were told to indicate the odd item out in each trial by circling "1", "2", or "3", and to circle "0" if they heard the same phrase three times. They were also instructed to respond to all trials, guessing if unsure. Once their doubts about the procedures were clarified, the training sequence of eight trials was played. Feedback was given after the sequence was completed to ensure that participants were acquainted with the materials and procedures. However, no feedback was given about the experiment trials. The listening-marking task was completed in 20 min without interruption.

Since one condition for the CDT to be judged successful is for it to yield a low error rate for native speakers (Flege, ms), the test was administered to three native speakers of American English who had been living in Brazil for six months at the time of testing. In order to make the task somewhat more difficult than it had been for the nonnative speakers, the test was administered in a noisy environment – a cafeteria, using a portable cassette tape recorder/player (CASIO Model TP-2) without headphones. Subjects were tested individually on three different days, at the same time of the day, and were not offered the training session.

5.6 Speech production data treatment and judgement procedures

The speech production data was treated to be rated by linguistically naive native speakers for the presence of an epenthetic vowel following the (C)CVC target word. The treatment and judgement procedures were carried out at the Speech and Hearing

Laboratory of the University of Alabama at Birmingham.

Participants' recordings in the speech production tests were digitized at 22.05 kHz with 16-bit amplitude resolution, using a Sony DAT tape recorder (model TCD D28) and a digitizing, mixing and editing software – Cool Edit 2000. Then the audio-stimuli from the two production tests were edited, also using Cool Edit 2000, by use of the following procedures: First, the speech samples – sentences or utterances – were converted into waveforms. Then the target/context portion of the waveform was edited out of each sentence or utterance and saved as a new sound file. These edited chunks, consisting of either a two-word sequence or a single word (when the context was a pause), were normalized to 50% for peak intensity.

During the chunking process some cases of misreading and other problems were identified and required careful analysis. First, there were sequences where a misreading changed the target or context sounds, or both. For example, for the excerpt 'breed elms' both [brit ɛlmɪs] and [brid lɛms] were discarded, because the phonological sequence produced was different from the intended one. Sequences where there was a misreading, but the target and context remained intact, such as [drɛd ɛlms] and [brid ɛzmɪs] for the same excerpt, were accepted. Second, some consonantal substitutions characteristic of the pronunciation of English by Brazilians were shown to be problematic. These were /ʒ/ for /dʒ/, /ʃ/ for /tʃ/, and /s/ for /ʃ/ in target position; and /f, s, t/ for /θ/, /d/ for /ð/, /x/ for /r/, /ʃ/ for /tʃ/, and /ʒ/ for /dʒ/ in context position. It was necessary to eliminate these substitutions as well.

Two native listeners helped the researcher to resolve cases of uncertainty in regard to the first two problems mentioned above. The chunks were played to them individually on a Sony notebook (model VAIO PCGF630) over headphones without

visual stimuli. The native listeners were told that they would hear beginning Brazilian students of English reading pairs of words or single words and that their task was to repeat what they had heard. In many cases the excerpt had to be played repeatedly because the pronunciation was very difficult for the natives to imitate. Once the target and/or context being checked was reproduced, the task was considered satisfactory. In case any doubts remained, the researcher asked the listener to explicitly specify the sound in question. In case of disagreement, and one of the listeners identified the consonant as the target/context intended, a third native listener was consulted. The sequences where the targets, contexts or both were not identified as the one(s) intended, whether because of misreadings or substitutions, were eliminated from the stimuli.

The third problem detected during the chunking of the participants' productions consisted of two-word sequences broken by coughing, throat clearing, laughter, filled and unfilled pauses. Filled pauses were expressions of hesitation – in most cases the Portuguese vowel /ɛ:/. Unfilled pauses were silent gaps equal to or longer than .4 s. It was reasoned that the phonological conditioning of the following consonant or vowel could not be claimed when that sound was not produced in immediate juxtaposition in the sequence. However, an established measure for this juxtaposition was not found in the literature. The lack of a solid criterion as to what constitutes a pause is acknowledged by Fortkamp (2000) in a study of fluency in L2 speech production. She cites a number of authors using different cut-off points, and adopts the measure of .5 s in her study, based on Deese (1980), Fillmore (1979) and Riggenbach (1989), who suggest that silent pauses of .4 s or less are normal breaks in the speech flow of nonnatives. This lack of criteria is even more evident in studies of the influence of phonological environment on speech production. In fact, the literature on phonological environment does not define a measure for the category 'pause'. Pauses are considered

in terms of the beginning or the end of an utterance, investigating production of onsets and codas, respectively (cf., Carlisle, 1991a; Baptista and Silva Filho, 1997; Abrahamsson, 1999; and Rebello, 1997). Abrahamsson (personal communication, March 11, 2001) comments that in his study of 1999 the slightest pause seemed to neutralize the enhancing effect of consonantal environments and the inhibiting effect of a vowel, and reports on a study being conducted on the coda production of Mandarin speakers of Swedish where "any kind of silence, no matter how long/short its duration" was considered a pause. In a study of consonant overlap at word boundaries, Zsiga (2000) defines a pause as a silent period equal to or greater than .35 s that characterizes disfluent tokens of native language C1##C2 sequences. In the present study, spectrogram and waveform analyses showed that most stretches of complete silence between the target and the context words lasted from .2 s to .4 s, and, for that reason, the cut-off point was determined at .4 s. Applying this criterion to the excerpts of the free speech test meant that all (C)CVC tokens produced were followed by a pause in the two tasks (directed speech and story re-telling) because there was always a latency time longer than .4 s between the two words in the sequences. This may be explained by the fact that, owing to the students' low level of English proficiency, there were only a few actual sentences produced – most utterances were isolated words, spoken in list mode.

All sequences broken by coughing, throat clearing, laughter, and filled pauses were discarded. The sequences of the sentence reading test containing unfilled pauses were also discarded, whereas those of the free speech test were analyzed separately as target/pause sequences. This differential treatment is due to the fact that in the sentence reading test, the types and numbers of targets were controlled, i.e., each target was followed by a particular phonological context once. Including more sequences of the type target/pause would cause an imbalance in the numbers and, thus, interfere with the analysis of the data.

A fourth systematic problem was the presence of an epenthetic vowel in the final consonant of the context word in sequences such as 'top bed', 'lab book', or 'deaf child'. In most cases the context word C/i/## was preceded by the realization of a target word C/i/##; however, because the second occurrence was at the end of the speech excerpt, it could easily attract the listeners' attention and influence the judgements. Thus the vowel portion in these C/i/## context words was edited out. Segmentation was based both on auditory and visual criteria using the Cool Edit 2000 waveform feature. Here again, two (other) native listeners helped the researcher to resolve cases of uncertainty. The context words were played to them individually on a Sony notebook (model VAIO PCGF630) over headphones and the orthographic representation of each word was provided on cards. The native listeners were told that they would hear beginning Brazilian students of English reading words and that their task was to identify the presence of an epenthetic vowel. In case of disagreement a third native listener was consulted.

A further problematic case to be resolved before the stimuli were prepared for the evaluation of a panel of native listeners was the high number of speech samples. As stated in Section 5.3, to solve this problem, the number of participants was randomly reduced from 34 to 20. However, after the speech samples of the two tests were edited, it became clear that this reduction was not enough for the judgement task to be feasible. Approximately 13 hours of judgement sessions would be required from each judge, which was considered to be neither possible in terms of availability of people and facilities, nor productive in terms of the reliability of judgements. The only criterion found which could reduce the number of tokens without detriment to the main variables investigated was to restrict the targets to be evaluated to those final consonants which are not possible in Portuguese. Therefore, data with /m/, /n/, /s/, and /z/ targets were

excluded from the present study. As mentioned before (see Section 5.4), the inclusion of these targets was related to the role of orthographic influence as an intervening variable of the study, since previous data seemed to point in this direction. For this reason, data of the excluded targets were kept for future investigations that will certainly add valuable contributions to the present one.

Originally, each of the 20 participants and the control speaker could have produced 456 chunks in the sentence reading test, where 19 targets were matched to 24 context words (see Section 5.4.2). This would have given a total of 9,576 chunks. However, the participants skipped 82 sentences, and the total of sentences produced was 9,494 (456 of the control and 9,038 of the participants). The elimination of problematic chunks, and of the chunks containing the /m/, /n/, /s/, and /z/ targets reduced this number to 4,758 chunks. Thus, the resulting audio stimuli consisted of 4,758 excerpts from the sentence reading test (4,499 of the participants and 259 of the control) and 151 excerpts from the free speech test – a total of 4,909 productions of (C)CVC words followed either by a CVC(C)(C) or VC(C) context word or by a pause. The measure reduced each judge's participation to approximately seven hours. This material was then organized to be presented to the native judges using the UAB-software Presentation Program. The 4,909 speech files were randomized and organized in sets so that each judge received a different randomization. There were 13 sets of 307 excerpts, and 3 sets of 306 excerpts. Each judge participated in five sessions – four sessions consisting of three sets and one session consisting of four sets. The audio stimuli were paired with visual prompts – orthographic representations of each two-word sequence or single word, so that the listener first received the visual and audio prompt simultaneously, and immediately after, the audio prompt alone a second time. It was indispensable to present the visual prompts because, as stated before, the speakers' pronunciation was often so

bad that the listener could be distracted by other features not related to the phonological error being investigated. The computer screen presented as little visual stimuli as possible – only the two buttons "yes" and "no" and the prompt.

Three native speakers of American English (2 male, 1 female) from Birmingham, Alabama, recruited through personal contact, rated the speech samples for presence of an epenthetic vowel following the target consonant. None of the judges had participated previously in speech research. Prior to participating in the experiment they passed a pure tone hearing screening (0.5 – 4.0 kHz, 20 dB HL) in both ears. The stimuli were presented on a notebook computer (Sony model PCGF630-VAIO), over headphones (Sony MDR 7506 Dynamic Stereo) in a sound booth. Each of the five rating sessions took approximately 1 hr 10 min and they were run every other day during a period of 10 days. The sessions were planned to be divided into three parts of 20 min with two intervals of 5 min, but, some were longer because listeners were free to pause at any time. They also had unlimited time to respond and could repeat a presentation as many times as they wanted, although they were asked to respond quickly according to their first impression, if possible. No session took more than 1 hr 20 min.

At the onset of the experiment, listeners were given both written and oral instructions (Appendix L), as well as a training session to familiarize them with the task itself and with other procedures allowed by the software, such as repeating a prompt and pausing. The task consisted of pointing the cursor to one of two buttons labeled "yes" and "no" on the screen using a mouse – "yes" for 'there is an epenthetic vowel in the last consonant of the target word' and "no" for "there is no epenthetic vowel". Listeners' answers were automatically saved in the response file in the UAB software.

5.7 Data analysis

The data gathered in the production and perception tests was analyzed and arranged for statistical treatment according to the criteria and procedures specified below.

5.7.1 Speech production data

The listeners' judgements were assigned the values "1" for "yes" responses – there is an epenthetic vowel in the last consonant of the target word – and "0" for "no" responses. These values were tabulated by chunk (target/context sequence), so that each chunk had three responses, one from each judge. Each chunk was considered to contain an epenthetic vowel only if at least two out of the three judges gave a "yes" response.

The resulting data was then arranged for statistical treatment in terms of the variables related to each hypothesis (see Section 5.2). The reading data was tabulated computing (a) the rates of epenthesis produced by subject for each target, to investigate Hypotheses 1 and 3; (b) the rates of epenthesis by subject for each class of targets (stops, affricates, and fricatives) to investigate Hypothesis 2; (c) the rates of epenthesis by subject for each context, to investigate Hypothesis 4; (d) the rates of epenthesis by subject for each SCN, to investigate Hypothesis 5; and (e) the rates of epenthesis produced overall by each subject, to investigate Hypothesis 6.

The free speech data was tabulated in the same way as the reading data in (c) and (e), and was used in an additional analysis of the correlation between results of the two types of production tests (see Section 5.4).

For the investigation of hypothesis 5, each chunk was assigned a syllable contact number (SCN), following the procedures in Baptista and Silva Filho (1997) and Rebello (1997). As explained in Section 3.3, these procedures included (a) assigning a consonantal strength value to the target and to the context of each chunk, according to Hooper's (1976) universal strength hierarchy (see Section 2.3); and (b) calculating the difference between each target and context value. For example, the sequences 'have cheap', 'wish Chuck', 'drive vans', and 'beach roads' obtained the SCN (-3), (-2), (0), and (5), respectively.

5.7.2 Speech perception data

The variable investigated in the perception test was the A-prime scores (see Section 4.6) in the CDT, calculated in agreement with the procedures explained in Flege et al. (1999), and Flege (ms).

A' scores were calculated by computing, for each subject, the percentage of correct answers in the different trials (HITS) and the percentage of errors in the catch trial, that is, the percentage of times subjects indicated an odd item out when there was none (false alarm – FA). The distractors were disregarded in the analysis. As explained in Section 5.4.4, these were included only to divert participants' attention from the objective of the test.

Snodgrass et al. (1985, p. 451) explains that the A' is a nonparametric analog of *d'* from Theory of Signal Detection (*d'* is the measure of sensitivity commonly used in signal detection experimentation), which does not require a large number of responses, and has the advantage over *d'* "of being calculable no matter what the hit and false

alarm rates are". According to Flege (ms) the A' permits the calculation of an unbiased measure of perceptual sensitivity to the phonetic contrast under investigation, since, to obtain a high score participants have to respond to relevant phonetic differences, ignoring irrelevant auditorily accessible differences between the stimuli, such as voice quality.

The formulas applied in the calculation of the A' are

1. If $H > FA$, $A' = 0.5 + \frac{(H - FA) * (1 + H - FA)}{4H * (1 - FA)}$
2. If $H = FA$, $A' = 0.5$
3. If $H < FA$, $A' = 0.5 - \frac{(FA - H) * (1 + FA - H)}{4FA * (1 - H)}$

(Snodgrass et al., 1985, p. 451)

An A' score of 1.0 indicates perfect sensitivity to the phonetic contrast examined. It occurs when all different and catch trials are responded to correctly. A value of 0.5 indicates lack of sensitivity and occurs when the H and FA rates are equal (Flege et al., 1999).

As in the speech production data, the resulting data of the CDT was arranged for statistical treatment in terms of the variables related to each hypothesis. The A' scores were tabulated for each subject to investigate Hypotheses 6.

For the two other hypotheses investigated in the perception test, the data was tabulated computing (a) the rates of correct answers in the different trials by subject for each target, to investigate Hypothesis 7; and (b) the rates of correct answers in the different trials by subject for each SCN, to investigate Hypothesis 8.

In the case of these two hypotheses it was not possible to calculate the A' scores because there were not catch trials for all targets, or for all SCNs. Owing to the diversity of targets and contexts included in the investigation it was not possible to have catch trials for all consonantal contacts. There was no specific criterion for the inclusion of targets and contexts of the catch trials.

5.8 Statistical analysis

The statistical techniques to address the research questions and hypotheses of the study were performed using the SPSS for Windows 10.0.

The analytic procedures used to assess whether the differences in the rates of epenthesis were statistically significant were Paired-sample *t*-tests and the Wilcoxon Signed Ranks Test. The *t*-test is a parametric instrument that compares the means of two variables for a single group, computing the differences between values of the two variables for each case and testing whether the average differs from 0 (SPSS for Windows 10.0, help menu).

In all cases, because the *t*-tests did not show statistically significant differences in the data examined, and to account for the fact that *t*-tests may be affected by the presence of outliers, which are "are atypical observations that are clearly separated from the bulk of the data" (http://www.acm.org/sigkdd/kdd2001/Tutorials/kdd2001_T2.html) a non-parametric instrument was also applied to the data – the Wilcoxon Signed Ranks Test. This test has more robustness since it does not depend on the absolute values of the differences between the rates, but it compares the distribution of the two rates (G. Villamonte, personal communication, June 2002). It is used to compare continuous data, considering "information about both the sign of the differences and the magnitude of the differences between pairs" (SPSS for Windows 10.0, help menu).

The analytic procedures used to assess whether and to what extent the relationships between variables were statistically significant were the Pearson Product Moment Coefficient of Correlation (*r*) and Spearman's Rank Order Correlation (*rho*). The Pearson Product Moment Coefficient of Correlation is a parametric test, considered the primary measure of linear correlation used to establish associations whenever the

data are measured on either interval or ratio scales (Goodwin, 1995; http://vassun.vassar.edu/%7Elowry/webtext.html). Spearman's Rank Order Correlation is a non-parametric technique. It calculates the associations taking into account ordinal data, that is, the rankings. As in the case of the Wilcoxon Test, this test was used as an additional procedure because it is in general considered more robust than the Pearson Correlation Coefficient since it is generally less affected by the presence of outliers in the data (G. Villamonte, personal communication, June 2002).

The probability level of statistical significance was set at .05 in the analyses.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Introduction

This chapter reports the results of the analysis of the data from the tests investigating the research questions and hypothesis formulated in the previous chapter (Section 5.2), and discusses the outcomes in light of pertinent theoretical developments and previous research reviewed in chapters 2, 3, and 4.

For each hypothesis, firstly, the **overall rates** computed for the variables are presented in order to make it possible to establish comparisons with data from previous studies, which, in general, reported the results in terms of percentages. Then the results of the statistical analyses performed on **data by subject** are reported. In all cases, the statistical analysis was performed by subject in order to account for two types of variability – between-subjects and within-subjects. Finally, the outcomes of each hypothesis are discussed.

The chapter is divided into three main sections. Section 6.2 reports and discusses the outcomes of the analysis on the data from the two types of speech production elicitation procedures used in the experiment – sentence reading and free speech. The data on the free speech test must be seen as an additional set collected in this experiment. As explained in Section 5.4, the question of task-type effects was not a main concern of the present study, but it was investigated in order to add data gathered without orthographic stimuli, providing some insight on the discussion of the influence

of different types of tasks on speech production elicitation. Thus, no hypothesis concerning the issue was formulated.

The results of the investigation addressing the research questions are then presented and discussed by variable and hypothesis separately. Section 6.3 addresses the speech production data and Section 6.4 addresses the speech perception data.

Concerning the data on speech production, as described in Sections 5.6 and 5.7.1, three native speakers judged the speech samples for the presence of an epenthetic vowel following the target consonant. The reliability of the judgements was tested by including a native speaker's samples in the stimuli. Of the total of 4,909 chunks judged, 4,499 chunks were from the participants' productions in the sentence reading test, 151 from their productions in the free speech test, and 259 chunks were from the native speaker's sentence readings. The rate of disagreement in the judgements was 4.2%, and the native speaker's productions were rated as yielding 0% of epenthesis, with disagreement of .07%. No pattern was detected in the disagreements concerning the judges or the type of judgement.

The speech perception test was also assessed for reliability through the collection of data with three native speakers of English. As mentioned in Section 5.5.4, one condition for the speech perception test (CDT) to be considered successful is that it yield a low error rate for native speakers. The native speakers' performance in the test was close to perfect (M = 99%, range = 97.2-100%) in the different trials, and (M = 100%) in the catch trials.

Before addressing each hypothesis of the study, it is important to compare the overall rates of epenthesis in Baptista and Silva Filho (1997), the study on which the present one was based – 15.2% – and in this study – 44.45%, in the reading test, and 44.55% computing the results of the reading tests and of the free speech test together – a

considerable difference probably related to the level of English proficiency of the students. Whereas the participants in the former study were undergraduate students in the first, second, and eighth semesters of the Letters Course, the participants of the present study were in the first and second semesters. The effect of level of instruction on epenthesis production has been noted by Fernandes (1997) and Major (1986, 1987a).

6.2 Task-type effects

One constant concern in speech performance experiments is the effect of the measurement instrument on the linguistic outcome expected or observed. The difficulty, and often, the impossibility of gathering natural language samples lead experimenters to design manipulated elicitation tasks to control for the specific phenomena under investigation. Despite the artificial character that language performance obtained from structured elicitation may have, gathering data from truly spontaneous speech may not only be difficult, but may also fail to provide representative amounts of linguistic data for analysis. In general, studies that tackle the question of task-based effects have borne out the hypothesis that "tasks which allow subjects to attend more closely to the form of their speech rather than to its content elicit a higher frequency of target variants" (Carlisle, 1991a, p. 76). This phenomenon of variation in speech is commonly known as *style shifting*, and has been most widely studied in the domain of sociolinguistics, investigating factors such as register, gender, and power relations (see Beebe, 1988; Ellis, 1986).

In L2, and specially in phonological variability, the phenomenon refers to shifts between more native-like and less native-like productions. Task effects on phonological

performance have been demonstrated in a number of studies (e.g., Beebe, 1980; L. Dickerson, 1974, 1975; W. Dickerson, 1976, 1977; Sato, 1983; Schmidt, 1977).

Major (1986, 1987, 1994b) and Weinberger (1987) investigated the effect of different tasks on epenthesis production, and Major's studies specifically focused on Brazilian Portuguese production of L2 English. The tasks designed for these studies ranged from more formal word-list reading to sentence reading, paragraph reading, or both, and to conversational speech.

Weinberger's subjects, four Mandarin speakers placed at a high intermediate level of English in a standardized test, did not show variation in their performance throughout three tasks: the reading of a word-list, and of a paragraph, and reporting a personal experience.

In Major's studies, beginning students in general presented more target-like productions in more formal tasks than in less formal ones. The speaking tasks in the 1986 and 1987 studies shifted from the reading of a word list, to the reading of sentences, to a text. In the advanced group of the 1987 study, although no significant differences appeared, Major identified a trend towards more target-like production in the more formal speech. In the 1994 study, an attempt to include beginning students' production through a free conversation test failed to yield enough data. In the other two tests, word-list and text reading, participants showed significantly more native-like productions in the text reading than in the sentence and word list reading, a result that is contrary to the expectations that the more formal tasks allow for more accuracy.

Major (1994b) credits this pattern of results to the influence of the linguistic environments in the two tests. Whereas in the word-list test the environment was always a pause, in the text, the target phones could appear in vocalic contexts, which according to the author favor native-like productions because they allow for resyllabification as in

the sky [ðəs$kay], which "though not precisely native, would probably not be heard as nonnative" (p. 671). He further comments that the difference in the formality of the two tasks – word-list reading and text – may not be sufficient to produce substantial differences in epenthesis production.

As Major (1986) acknowledges, the two fundamental reasons for using reading tasks in experiments investigating phonological variability are the possibility of controlling the linguistic environment in which the target occurs and of gathering data from L2 speakers at low levels of fluency. The outcomes of the free speech test in the present study seem to evince this argument. Not only was the quantity of ##CVC## tokens low (151), but they were also restricted to targets in the environment of a pause, either because the participants produced words in list mode, or because of their hesitations.

Although the students' level of L2 proficiency was known to be low, it was expected that they would be able to produce more language in the free speech test than in fact they did, especially in the directed speech task, which did not require linguistic elaboration beyond that which they were used to doing in their English courses. Besides the lack of fluency in the language, another factor might have contributed to their difficulty – the testing situation itself might have been overwhelming to some participants. For many of them the experiment session was their first time in a language laboratory, and also the first time they had their speech recorded. Although they knew that the material collected was to be treated as anonymous, it was obvious that some students were shy and ashamed of their low level of fluency. The situation could have been different if the recordings had been collected in individual sessions, but time constraints and participants' availability did not allow for that.

Table 6.1 shows the epenthesis rates overall, computing the participants' productions in the reading test and in the free speech test:

Table 6.1

Overall rates of epenthesis in the reading test and in the free speech test

	Sentence reading test	Free speech test	TOTAL
N° Productions	4,499	151	4,650
N° Epenthesis	2,000	72	2,072
% Epenthesis	44.45%	47.68%	44.55%

The results from the Pearson Product Moment Correlation comparing participants' performance in the reading test and in the free speech test showed a moderate, non-significant correlation, r (20) = .30, $p > .05$, whereas the analysis of this data using Spearman's Rank Order Correlation also showed a moderate correlation, but significant at the .05 level, *rho* (20) = .39, $p < .05$.

These results show that the relationships between the absolute values of the rates of epenthesis in the two tests are not significant; however, the relationships between the levels of the rates are significant. It was reasoned that, since the data from the free speech test consisted of ##CVC## in the context of a pause, it was interesting to establish an association with the same type of data from the reading speech test. Thus, further tests were run between the data from the free speech test and the portion of data from targets produced in the context of a pause in the reading test. Table 6.2 shows this data:

Table 6.2

Overall rates of epenthesis in the reading test (context-pause) and in the free speech test

	Sentence reading test/ PAUSES	Free speech test
N° Productions	207	151
N° Epenthesis	95	72
% Epenthesis	45.89%	47.68%

The results from both the Pearson Product Moment Correlation and Spearman's Rank Order Correlation reached significance when comparing these sets of data, r (20) = .51, $p < .05$, and *rho* (20) = .50, $p < .05$, respectively.

Summing up, the results from the correlation tests between the first association (reading test and free speech test) showed moderate correlation, reaching significance with the non-parametric method, which is less susceptible to be affected by the presence of outliers in the data, and, in the second type of association (reading test-context-pause and free speech test) the correlation coefficients with both the parametric methods and the non-parametric increased and reached significance.

These results indicate that a clear tendency can be identified for participants who produced more epenthesis in the sentence reading test to produce more epenthesis in the free speech test as well. The association between the two types of data is shown to be stronger when taking the portion of data of the reading test from targets produced in the context of a pause. Thus, taken together, the data in this study fail to demonstrate the effect of task in the production of vowel epenthesis following word-final consonants.

It must be noted that in this study, as in the ones mentioned above, task-type effect on phonological acquisition was studied as a secondary variable, thus the results can only be seen as preliminary data that are expected to motivate future specific investigations, from more controlled experiments that will validate conclusions. Since owing to the difficulty of gathering speech data from natural observation, researchers are left with the task of manipulating elicitation techniques, the effect of these techniques on experimental outcomes deserves a much sharper focus than it has in general been given.

6.3 Variables of speech production

This section reports and discusses the results of the analyses on the speech production data gathered through the sentence reading test. Three hypotheses of markedness and two of phonological environment were investigated.

6.3.1 Variables of markedness

The three variables of markedness investigated addressed the following research questions:

(a) Does markedness in terms of voicing of the target consonant influence epenthesis production (investigated in Hypothesis 1) ?;

(b) Does markedness within the class of obstruents influence epenthesis production (investigated in Hypothesis 2)?; and

(c) Does markedness in terms of place of articulation of the target consonant influence epenthesis production (investigated in Hypothesis 3)?.

6.3.1.1 Voicing of the target consonant – HYPOTHESIS 1

Hypothesis 1 predicted that voiced consonants would cause more epenthesis than their voiceless counterparts.

As mentioned in Section 3.2.2, the influence of markedness in terms of voicing has been attested in studies of final consonant devoicing, which have shown that the

strategy is considerably consistent even in the IL of speakers whose NLs do not have a devoicing rule and have voicing contrast in initial position.

The characterization of voiced and voiceless consonants in terms of degrees of markedness is explained by Eckman (1977/1987a) to exemplify the notion of implicational markedness as follows: whereas there are languages with voiceless obstruents exclusively, and languages with both voiced and voiceless obstruents, there seem to be no languages with just voiced obstruents. Thus, the occurrence of voiced obstruents in a language implies the occurrence of voiceless obstruents; however the reverse implicational relation does not hold.

Five pairs of consonants were analyzed in terms of voicing: /b/-/p/, /d/-/t/, /g/-/k/, /v/-/f/, and /dʒ/-/tʃ/. Table 6.3 shows the overall rates of epenthesis for each voicing pair. Although data was collected for the voiceless alveopalatal fricative /ʃ/, it was not included in this tabulation of results because its voiced counterpart /ʒ/ was not tested in this study (see Section 5.4.2):

Table 6.3

Overall rates of epenthesis after obstruents – voiced/voiceless pairs

		Bilabial Stops	Alveolar Stops	Velar Stops	L-dental Fricatives	Alveopal. Affricates	Total
Nº Prod	[-vd]	424	400	420	410	398	2,052
Nº Epen	[-vd]	188	175	192	190	167	912
% Epen	**[-vd]**	**44.33%**	**43.75%**	**45.71%**	**46.34%**	**41.95%**	**44.44%**
Nº Prod	[+vd]	423	424	402	428	360	2,037
Nº Epen	[+vd]	184	191	187	192	158	912
% Epen	**[+vd]**	**43.49%**	**45.04%**	**46.51%**	**44.85%**	**43.88%**	**44.77%**
Total Nº Prod		847	824	822	838	758	4,089
Total Nº Epen		372	366	379	382	325	1,824
Total %		**43.91%**	**44.41%**	**46.10%**	**45.58%**	**42.87%**	**44,60%**

As can be seen in table 6.3, of the five pairs examined, three obstruents yielded

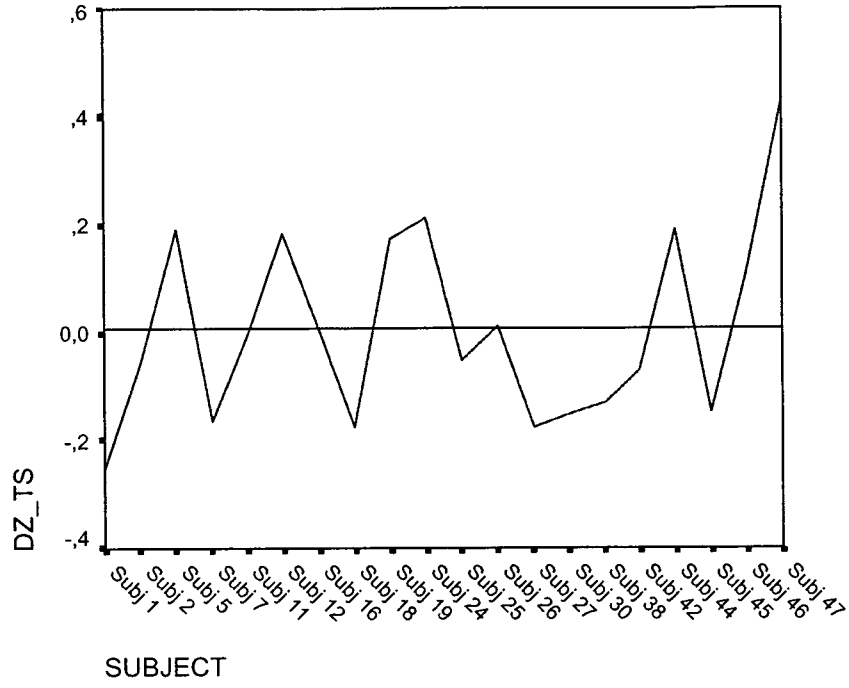
higher rates of epenthesis for voiced than for voiceless counterparts, as predicted in the hypothesis – the alveolar and the velar stops, and the affricates; however, the statistical procedures revealed no significant differences ($p < .05$) between any of the voicing pairs; thus Hypothesis 1 did not find statistical support in this study.

Paired-sample *t*-tests yielded results as follows: for bilabials stops, $t = .26$; for alveolar stops, $t = -.55$; for velar stops, $t = -.29$; for labiodental fricatives, $t = .64$; and for alveopalatal affricates, $t = -.14$. Equally, the non-parametric Wilcoxon Signed-Ranks Tests failed to reveal significant differences in the production of epenthesis following voiced and voiceless pairs of consonants: for bilabial stops, $z = -.50$; for alveolar stops, $z = -.16$; for velar stops, $z = -.37$; for labiodental fricatives, $z = -.70$; and for alveopalatal affricates, $z = -.24$.

Sequence-graphs were designed for each pair of targets, allowing visualization of the variability in the differences of rates for each subject. The horizontal line in the graph shows the overall average of these differences. The points above the line correspond to the participants who had higher rates of epenthesis in the voiced than in the voiceless counterpart, and the ones below the line correspond to the participants who had the inverse performance. Figure A depicts the data for affricates (see the data for the other pairs in Appendix M). As can be seen in the graph, the distribution of subjects above and below the line is quite balanced in relation to the means of the differences by subject, again showing a lack of significant difference between the voiced and voiceless pairs:

Figure A

Variability in the differences of rates for affricates for each subject



The results of this study contrast with those of Sekiya and Jo (1997), in which the difference between the rates of epenthesis for voiced and voiceless final consonants in the English IL of Japanese speakers was significant (the difference was strikingly accentuated in this study, reaching significance at .001 level). Although not inconsistent with the results of Baptista and Silva Filho (1997), the present study does not seem to provide much support for them either. However, there was an intriguing coincidence in the two studies: the two classes of obstruents that did not conform to the expected tendency were the same in both – the bilabial stops and the labio-dental fricatives. In Baptista and Silva Filho the two pairs had exactly the same rates for voiced and voiceless targets, whereas in the present study, the rates for the voiced counterparts were somewhat higher than those for the voiceless ones.

As mentioned in Section 3.2.2, Baptista and Silva Filho suggest a possible explanation for the exception based on Yavas (1994, 1997), who found that final stops

yielded more devoicing as the place of articulation moved progressively back from bilabials to alveolars, and then to velars. The author relates the greater facility in the production of the voiced bilabial (than in the production of the voiced alveolar and velar) to the exploration of a larger space in the oral cavity, making the air exert a lower pressure in the supraglottal area. As Baptista and Silva Filho conclude, if bilabials are less susceptible to devoicing, it seems reasonable to suspect that speakers who epenthesize do not apply the strategy more frequently for voiced than for voiceless bilabials for the same reason.

The fact that both the present study and that of Baptista and Silva Filho yielded results for the labial consonants that either neutralized the voicing difference or contradicted the direction of the difficulty predicted by markedness, seems to indicate that when a greater supraglottal area is involved, voicing does not play a role; that is, place of articulation may overrule the influence of voicing in this case.

Although, owing to the lack of statistical support, the whole set of results on markedness by voicing cannot be interpreted as indication of more than a tendency, the coincidence in the pattern obtained in two studies investigating BP speakers leads to implication that the tendency must be acknowledged and taken into consideration in further examinations.

The overall high rate of epenthesis taken together with the lack of significant results in terms of markedness by voicing, seems to indicate that L1 interference overrules markedness effect in the initial stage of L2 acquisition.

6.3.1.2 Relative markedness within the class of obstruents – HYPOTHESIS 2

The second hypothesis of markedness investigated was concerned with relative markedness within the class of obstruents. Based on a claim made by Eckman and

Iverson (1994, see Section 3.2.2), the hypothesis predicted that affricates (/tʃ, dʒ/) would cause more epenthesis than fricatives (/f, v, ʃ/), which would cause more epenthesis than stops (/p, b, t, d, k, g/). Table 6.4 shows the overall rates of epenthesis for the three classes of obstruents:

Table 6.4

Rates of epenthesis by class of obstruents

	STOPS (bilabial, alveolar & velar	FRICATIVES (lab-dental & alveopalatal)	AFFRICATES Alveopalatal
Nº Prod	2,493	1,248	758
Nº Epen	1,117	558	325
% Epen	44.80%	44.77%	42.87%
Median % Epen	42.15%	45.20%	42.38%

Paired-sample *t*-tests on the differences of the rates of epenthesis computed by subjects showed no statistically significant difference ($p < .05$) among the three sets of data: for the pair affricates-fricatives, $t = -1.13$; for fricatives-stops, $t = -.004$; and for affricates-stops, $t = -.96$. No significant difference ($p < .05$) was detected by the Wilcoxon Signed-Ranks Test either: for the pair affricates-fricatives, $z = -.78$; for fricatives-stops, $z = -.14$; and for affricates-stops, $z = -1.19$.

These results appear to indicate a lack of support for Hypothesis 2, since the means overall showed an inverse ranking of that predicted in the hypothesis and corroborated by Baptista and Silva Filho (1997) for affricates and stops. Whereas in this study the overall rate of epenthesis for affricates was the lowest, and for the stops, the highest, in Baptista and Silva Filho, the reverse ranking occurred.

Affricates have been treated inconsistently in the sonority or strength hierarchies. As mentioned in Section 2.3, most propositions do not include these consonants in the

rankings, and Hooper (1976) suggests that, owing to their articulatory complexity, and to strengthening processes characteristic of some languages that favor shifting from stops to affricates, these consonants must be ranked in the highest position. As such, affricates are expected to cause more difficulty than the stops.

In fact, affricates were shown to cause problems for the participants of the study, since 202 chunks had to be eliminated from the original data gathered because of mispronunciations. However, these mispronunciations were in the sense of turning affricates into alveopalatal fricatives, a weakening process. There would appear to be no obvious reason for this tendency, considering NL transfer. Clear L1 interference would have turned affricates into stops, since 12 out of 20 participants were from a geographical region where the final sequences 't' and 'd' plus 'e' or 'i' are pronounced as stop plus /i/, as a marked dialectal characteristic, in contrast with palatalization of these sequences in other regions of the country. However, it seems likely that the weakening process by itself may be attributed to LI interference in terms that there was a certain resistance to making use of a sound which is recognized as characteristic of a dialect of a prestigious region in the country. Thus, acting in conjunction with the low level of proficiency in the L2, which accounts for uncertainty about how to pronounce affricates, the weakening process preserved the more salient portion of the segment. Another possibility concerning L1 interference is the fact that 'ch' sequences are pronounced [ʃ] in BP. It must be noted that this interpretation cannot go beyond mere speculation on the matter since there is no clear evidence on which to base an argument from the results of the analysis carried out in this research.

The results for stops and fricatives obtained in this study go in the direction of the results of Tropf (1987), that is, more modification in the final stops than in the final fricatives; however, the difference between the two groups of obstruents is minimal, and as

such cannot characterize a tendency. The markedness relation claimed by Eckman and Iverson (1994) for fricatives and stops contradicts that posited by Hooper (1976) and Selkirk (1982). The strength or sonority hierarchies proposed by these authors and other hierarchies (e.g., the one used by Dziubalska-Kolaczyk, 1997; Foley, 1972, cited in Clements, 1990, p. 286) in general place fricatives in a more sonorant (less marked) position than stops.

A survey in the literature shows that both the discussion of sonority hierarchies and the discussion of markedness relations in terms of sonority are open to contributions. Studies of cross-language phonology play an important role in this debate and the need for further research is emphasized by the lack of a consistent direction in the results from the studies available up to the present.

In the case of the present study, the difference in the overall rates for fricatives and stops is minimal and as such it does not seem to lend support to any claim with respect to the directionality of the relation. However, as the results obtained here, on the one hand, contradict both Eckman and Iverson's (1994) claim and the results of Baptista and Silva Filho (1997), and, on the other hand, go in the direction which would be preferred by some of the most widely cited sonority or strength hierarchies, which are corroborated by another piece of research data (Tropf, 1987), they suggest that much elucidation about sonority relations might come from L2 studies focusing on this restricted area.

6.3.1.3 Relative markedness among voiced stops by place of articulation – HYPOTHESIS 3

Hypothesis 3 predicted that the voiced velar stop would cause more epenthesis

than the voiced alveolar, which, in turn, would cause more epenthesis than the voiced bilabial. As can be seen in Table 6.3, the overall epenthesis rates for the three voiced consonants ranged from 46.51% for the velar to 45.04% for the alveolar, then to 43.49% for the bilabial. The medians obtained for the three voiced obstruents were 45.23% for the velar, 43,56% for the alveolar, and 41,74% for the bilabial, following the same tendency.

Paired-sample *t*-tests on the differences in the rates of epenthesis computed by subjects yielded the following results (non-significant at .05 level): for the pair alveolar-velar, t = -.58; for alveolar-bilabial, t = -.52; and for bilabial-velar, t = -.80. The Wilcoxon Signed-Ranks Test yielded non-significant results as well: for alveolar-velar, z = -.76; for alveolar-bilabial, z = -1.02; and for bilabial-velar, z = -.89.

Although not statistically significant, taken together the results can be interpreted as indicating a tendency in the direction predicted by Hypothesis 3, expressed in the means and in the medians of all subjects.

These results corroborate those of Baptista and Silva Filho (1997). An overall tendency for more modification with the voiced velar than with the voiced alveolar might be expected, considering that Sekiya and Jo (1997) found the same pattern concerning devoicing – more modification with the velar than with the alveolar (there were not enough tokens of the voiced bilabial to allow for investigation).

These coinciding tendencies in the results of Baptista and Silva Filho and of the present study seem to offer substantiation to hypothesize that Yavas's (1994) claim about the influence of place of articulation on the devoicing of final consonants can be extended to epenthesis production after voiced stops by speakers who employ this remedial strategy to overcome pronunciation difficulties (see discussion of H1).

6.3.2 Variables of phonological environment

The two variables of phonological environment investigated addressed the following questions:

(a) Does phonological environment in terms of vowels, consonants and pauses influence epenthesis production (investigating Hypothesis 4)?; and

(b) Do strength relations across syllables influence epenthesis production (investigating Hypothesis 5)?.

6.3.2.1 Phonological environment – HYPOTHESIS 4

Hypothesis 4 investigated whether phonological environment affected epenthesis production, predicting that more epenthesis would be produced in the context of consonants than vowels, which in turn, would cause more epenthesis than pause. Table 6.5 shows the overall rates of epenthesis for each phonological context:

Table 6.5
Rates of epenthesis by phonological environment

	Consonant	Vowel	Pause
Nº Productions	3,684	608	207
Nº Epenthesis	1,624	281	95
% Epenthesis	44.08%	46.21%	45.89%
Median % Epen	43.17%	46.66%	42.73%

As can be seen in the table, the highest overall rate of epenthesis was for the vocalic context, followed by silence, then consonants, a ranking that does not go in the direction of the hypothesis.

The statistical analyses showed no significant effect ($p < .05$) of phonological environment on epenthesis production measured both by paired-sample *t*-tests and by the Wilcoxon Signed-Ranks Test. The procedures yielded the following results: for the pair consonant-vowel, $t = -.86$; for vowel-pause, $t = -.01$; and for consonant-pause, $t = -.53$; and for the pair consonant-vowel, $z = -.97$; for vowel-pause, $z = -.37$; and for consonant-pause, $z = -.14$, respectively.

Thus, statistically, the effect of the phonological environment, in terms of a consonant, a vowel, or silence on epenthesis production was not found to be significant. The higher overall rate for the vocalic environment was surprising, especially considering that care was taken to avoid /i, y/ as context phonemes in order not to provoke epenthesis by coarticulation or to mask epenthesis, or at least, make it difficult to perceive, especially since there is a greater tendency in Portuguese than in English to run adjacent vowels together. Recall that the vocalic contexts were limited to words beginning with /ɛ/, /æ/, /ɑ/, ʌ/, /ɔ/, and /oʊ/ (see Section 5.4.2). This outcome might be taken to reinforce the observation that the participants' level of fluency was quite low, favoring linguistic processing at the word level. Were the participants more fluent, maybe the vocalic contexts could have favored the resyllabification effect identified by Major (1994b) as the cause of low epenthesis in an experiment of /sC/ initial clusters (see Section 6.2).

Compared to the results of Baptista and Silva Filho (1997), where the highest rate of epenthesis was for consonants, followed by vowels, then pause, the ranking obtained in the present study (highest rate for vowels, followed by pause, then consonants) shows a completely different order, thus the hypothesis did not find support even in terms of expressing tendencies. The only previous study investigating this variable with BP learners (Tarone, 1980/1987) shows a third order, ranging from the highest rate for pause, to consonants, and then vowels.

Inconsistent findings concerning the effect of consonants and vowels in the environment are reported by Abrahamsson (1997, 1999), Carlisle (2001, and elsewhere), and Rebello (1997) investigating /sC(C)/ initial clusters. Both Abrahamsson and Carlisle have systematically found that consonants are responsible for more frequent epenthesis than vowels in studies of epenthesis production in Spanish speakers' Swedish and English ILs, respectively. Rebello found the reverse effect investigating the phenomenon with BP speakers.

Thus, the results of the present study can only be taken as a contribution to the present state of the art in terms of showing that it is not possible yet to point confidently in any direction, even in terms of tendencies, concerning the effect of a consonant, a vowel, or a pause in the context of sequences that are markedly prone to be epenthesized.

6.3.2.2 Strength relations across syllables – HYPOTHESIS 5

Concerning the question of the influence of strength relations across syllables in epenthesis production, Hypothesis 5 predicted that the greater the difference in consonantal strength between the target and the context consonant the greater would be the frequency of occurrence of epenthesis. As explained in Section 5.7.1, strength relations were established by assigning syllable contact numbers (SCN) to the target/context sequences, based on Hooper's (1976) scale (see Section 2.3). Although affricates were not included in the hierarchy, in the present study, as in Baptista and Silva Filho (1997), they were added with strength value of (7) (again, see 2.3). SCNs obtained from the computation of the target/context differences ranged from (-3) to (6). Table 6.6 shows the raw numbers and rates of epenthesis by SCN:

Table 6.6
Rates of epenthesis by syllable contact number (SCN)

SCN	-3	-2	-1	0	1	2	3	4	5	6
N° Productions	34	222	530	904	719	531	354	240	115	35
N° Epenthesis	13	99	229	395	322	218	162	121	46	18
% Epenthesis	**38.23**	**44.59**	**43.20**	**43.69**	**44.78**	**41.05**	**45.76**	**50.41**	**40.00**	**51.42**

The *t*-tests and Wilcoxon tests on the rates of epenthesis by subject for each SCN 'pair' in the sequence yielded no significant results (p <.05). The table below shows the differences for each pair of data yielded with the two tests:

Table 6.7
Values of the differences for each SCN 'pair' with the Paired-Sample t-Tests and with the Wilcoxon Signed-Ranks Test

SCN	(-3)-(-2)	(-2)-(-1)	(-1)-(0)	(0)-(1)	(1)-(2)	(2)-(3)	(3)-(4)	(4)-(5)	(5)-(6)
t	-.33	.10	-.19	-.49	1.42	-1.46	.44	.49	-1.68
z	-.31	-.14	-.36	-.52	-1.71	-1.04	-.41	-.46	-1.65

In spite of the lack of statistically significant differences among pairs, Table 6.6 shows that, according to expectations, there was a slight tendency for epenthesis rates to gradually increase with the SCN. This slight tendency is shown in the results from the Pearson Product Moment Coefficient of Correlation and Spearman's Rank Order Correlation between rates of epenthesis and SCN, which indicate a moderate correlation (r = .54, and *rho* = .50, respectively), but non-significant at the .05 level.

The lack of significance does not allow the claim that these results corroborate those of Baptista and Silva Filho (1997); however, it can be said that they are at least consistent with the results of the previous study, showing a weaker tendency.

The hypothesis of syllable modification as a factor of differences in consonantal strength across syllables is based on Murray and Vennemann's (1983) SCL, which postulates that the probability of changes in a syllabic contact increases with the value of the difference between the first and the second marginal segments, that is, with the

value of *a-b* (see Section 2.6). Thus, it was reasoned that the data could be analyzed in three sets made up of sequences where $a < b$, $a = b$, and $a > b$ (negative SCNs, SCN (0), and positive SCNs, respectively). Analyzing Baptista and Silva Filho's data in this manner these sets yielded the following results: 8.9%, 12.2%, and 16.77%; and in the present study the results were 43.38%, 43.69%, and 44.48%, characterizing a gradual increase in the overall rates of epenthesis in both studies, although the differences in rates obtained in the present study are much smaller.

There are some factors involved in the analysis of data in terms of SCN that need to be taken into account. First, there is a considerable degree of imbalance in the data in this type of analysis. This may be due to the fact that the farther the SCN gets from (0), the more restricted the number and the types of targets and contexts involved in the computations. Second, as observed by Baptista and Silva Filho (1997), NL transfer has to be considered in the selection of the targets and contexts to be analyzed. The authors cite the target /s/ included in their study, which as one of the few possible final consonants in BP, is not expected to cause epenthesis. The inclusion of /s/ targets (strength value 5) might have interfered with the results of rates of epenthesis for SCNs obtained from calculations where the target value 5 was involved. The same case can be made for the nasals included in the study (see Section 5.4.3.1 for the reasons why /s, z, m, n/ were treated differently in the present study). Third, also as observed by Baptista and Silva Filho, in their study (as in the present one) it was assumed that the intervals between the numbers in Hooper's (1976) hierarchy were equal. It must be noted that no reference to intervals within rankings was encountered in the literature on sonority or strength hierarchies reviewed in Chapter 2 in the present dissertation. As remarked by the authors, variable intervals would "interfere with the accuracy of SCN classifications, and thus, with the overall tendency" (p. 31).

A further point to be borne in mind when dealing with SCN data concerns the lack

of agreement on a universal hierarchy up to the present time, as Baptista and Silva Filho have commented. The results of analyses involving SCN computations have to be interpreted in terms of the specific hierarchies on which values were assigned to the segments in contact.

It is particularly in relation to the debate about hierarchies that the contribution of this line of research might be seen. In spite of the complexity peculiar to research involving computations of SCN, such research may be exceptionally relevant in helping to refine the concept of sonority or strength, and in adding to the discussion of the existence of a universal sonority hierarchy.

In this sense, it would be interesting to compare results of analyses assigning SCNs in accordance to hierarchies like Hooper's (1976) and the one used by Dziubalska-Kolaczyk (1997), which show different rankings for stops, fricatives and affricates, and make different claims concerning the relationship between voicing and sonority or strength.

6.4 Variables of speech perception

This section reports and discusses the results of the analysis on the speech perception data gathered through the CDT test. Three questions were investigated: the first addresses the relationship between speech perception and production; the second addresses the influence of markedness in terms of voicing of the target consonant in the discrimination of ##CVC## and ##CVCV## sequences; and finally, the third investigates the influence of strength relations across syllables in the discrimination of these sequences.

6.4.1 Relationship between perception and production – HYPOTHESIS 6

Hypothesis 6 predicted that there would be a relationship between speech perception and production, that is, that subjects who produced more epenthesis would fail more frequently to discriminate ##CVC## and ##CVCV## sequences where the final vowel was /i/.

The variables involved in establishing the association between the data from the perception and production tests were the A' score obtained for each subject in the perception test (CDT) and the rate of epenthesis produced by each subject in the sentence reading test. Table 6.8 displays participants' rates of epenthesis in the sentence reading test, the correct discrimination rates (HIT) and the false alarm rates (FA), and the resulting A' scores (see Section 5.7.2):

Table 6.8
Rates of epenthesis in the sentence reading test and A' scores in the CDT test

Subject	% Epen	% HIT	% FA	A'
1	.40	.86	.42	.82
2	.50	.39	.67	.28
5	.36	.17	.17	.50
7	.60	.69	.25	.81
11	.54	.33	.58	.30
12	.44	.31	.17	.66
16	.56	.14	.42	.25
18	.47	.33	.58	.30
19	.62	.17	.50	.23
24	.53	.28	.67	.22
25	.43	.22	.33	.38
26	.35	.17	.17	.50
27	.39	.47	.58	.40
30	.32	.17	.25	.30
38	.42	.31	.42	.39
42	.44	.08	.50	.18
44	.36	.19	.42	.30
45	.38	.11	.33	.27
46	.40	.25	.42	.34
47	.38	.44	.25	.67

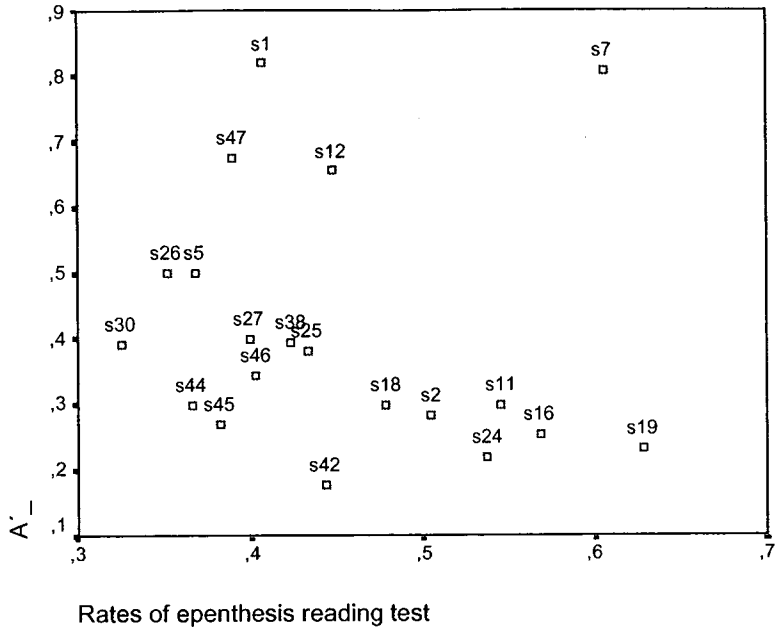
The table shows that, in general, the A' scores were extremely low. Fourteen of the twenty participants had A' scores lower than .05, a value which characterizes 'lack of sensitivity' (again, see Section 5.7.2), two participants scored exactly .05, and only four obtained A' scores higher than that. Of these four, only two participants had A' scores approximating the 'perfect sensitivity' value (1.0) – participants 1 and 7, who scored .82 and .81, respectively.

It must be recalled that the calculation of A' scores computes the proportion of correct identification of odd items and the proportion of false alarms, that is, the times an odd item was indicated when there was none (all tokens were the same). Thus, the low A' scores mean not only that participants had difficulty in identifying the odd items, but also that they believed they heard an odd item when the three tokens of the stimulus were the same, characterizing lack of perceptual sensitivity.

Figure B below suggests the expected negative correlation between A' scores and rates of epenthesis; however, the statistical tests showed that the correlation was only weak to moderate. A -.15 correlation coefficient was found with the Pearson test, and a -.33 coefficient with Spearman's test.

Figure B

Relationship between A' scores in the CDT test and epenthesis rates in the sentence reading test



Since Spearman's correlation yielded a larger correlation coefficient, and thus a greater statistical significance (p = .26 with the Pearson method, compared to p = .07 with Spearman's method, approximating the level of significance of .05), it was reasoned that there might be outliers in the data, interfering with the Pearson correlation. Recall that Spearman's Rank Order Correlation is less affected by the presence of outliers.

The outliers were identified based on the standard deviation values in the A' scores. The two participants spotted as outliers were the ones whose A' scores fell 2 or more SD from the mean, who were also two of the four scoring above the 'lack of sensitivity' level.

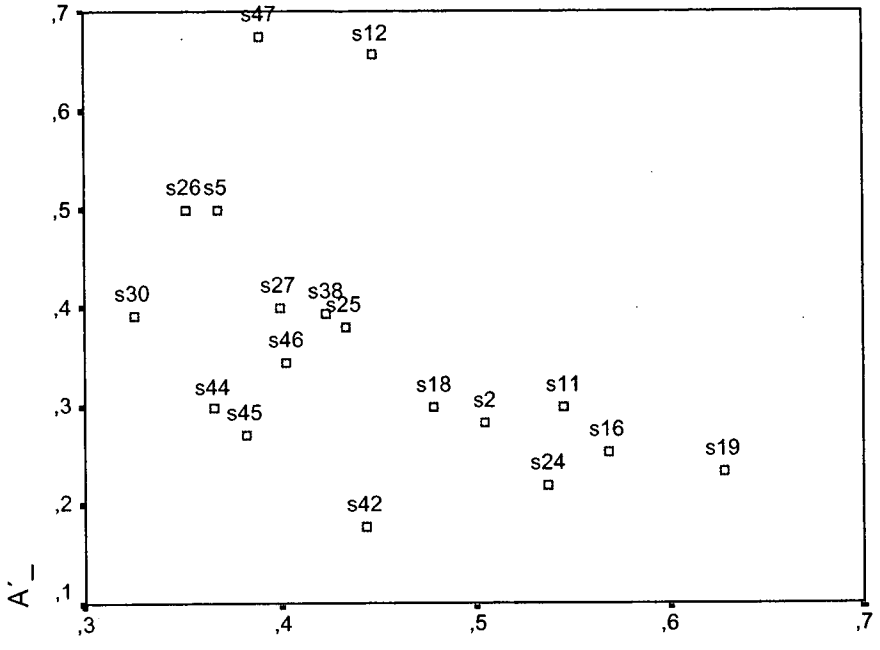
The identification of outliers allowed for a further analysis of the data to examine whether the degree of association between the two variables would be affected by computing more uniform data. The analysis yielded the following data: with the Pearson Product Moment Coefficient of Correlation, r (18) = -.49, p = .01, and with Spearman's

Rank Order Correlation, rho (18) = -.54, p = .01, that is; the degrees of association increased, and reached statistical significance ($p < .05$) with both tests.

Figure C shows the association between the A' scores and epenthesis rates in the sentence reading test without the outliers:

Figure C

Relationship between A' scores in the CDT test and epenthesis rates in the sentence reading test without the outliers



Taken together, the results of the correlation analyses lend support to Hypothesis 6. The association is clearly negative taking the data with and without outliers. In other words, these results show that, as participants' scores in the perceptual test decrease, their rates of epenthesis tend to increase. The presence of outliers was shown to affect the results, as indicated by the greater correlation coefficient and significance level with Spearman's Rank Order Correlation including all participants, that is, when the participants' scores were rank ordered, than with the Pearson coefficient. The analysis of the data without the outliers showed that the association increased considerably with

both statistical procedures, reaching a stricter statistical level of significance with both the parametric and the non-parametric tests.

The relationship between perception and production was investigated in this study mainly based on Flege's (1995) SLM (see Section 4.3). Specifically, the investigation aimed at answering the question of whether or not an association could be detected between discrimination of ##CVC## and ##CVCV## sequences where the final vowel is an /i/ and epenthesis production in word-final consonant codas.

It was expected that such an association would become apparent when measured by correlation tests between participants A' scores and their rates of epenthesis in the sentence reading test, the measures of speech perception and production applied. The pattern of results reported above indicates that participants' perception and production performance were intrinsically associated, thus bearing out the expectations.

Correlation data between perception and production in L2 has been shown in studies at the segmental and non-segmental level (see review in Section 4.5). Differential performance according to L2 proficiency was reported by Flege and Schmidt (1995), in which, whereas proficient subjects' perception and production correlated significantly, non-proficient subjects' performance did not reach significance (proficiency measured by overall degree of perceived foreign accent in English sentences). Other studies show differential performance of experienced and non-experienced or early and late L2 speakers; however, in general, language proficiency itself is not assessed in these studies. The literature on the L2 speech perception-production relationship reports on studies of language acquisition in natural settings. No study was found reporting assessment of the relationship in instructional settings. The degree of exposure to the foreign language in question is extremely different in the two situations, a factor that undoubtedly has to be taken into account, and gives significance

to the research project undertaken in this dissertation.

As observed in the Introduction section of this chapter with relation to the notably high rates of epenthesis, the overall outcomes of the study are very probably a reflection of the participants' low level of proficiency in the L2. In this sense, a clearer image of the relationship between L2 speech perception and production will only be possible when data from longitudinal studies are added to this initial step.

The pictures conveyed by this study focused on a specific point in the process of L2 speech acquisition by a group of adults in a non-natural setting. The production picture showed that this group of adult L2 'false-beginners', native speakers of a language in which final obstruents are not welcome, consistently employed vowel epenthesis as a remedial measure to deal with these sounds when reading a series of sentences in the L2 in question. Since vowel epenthesis is the strategy most widely used in these speakers' L1 to deal with undesirable syllable-final obstruents in loanwords, its utilization to cope with the same type of L2 sequences seems to characterize foreign accent.

The perception picture showed that this same group of learners consistently failed to distinguish L2 sequences ending in an obstruent from sequences where /i/, the vowel applied in epenthesis production, is added to these consonants. Would that be a manifestation of 'perceptual foreign accent', as characterized by Strange (1995, see Section 4.2), in the processing of the final consonant? Would these learners be interpreting the L2 input through the 'grid' or 'sieve' of the L1 phonetic system?

Taking L1 factors as reference, it seems likely that this is the case. L1 speech sound perception is highly characterized by the ability to deal with irrelevant contextual and allophonic variants of the early established prototypes, so that variation does not interfere with the processing. The hearer 'hears through' the variation and interprets it as a realization of the prototype (Best, 1995). There is great individual, dialectal, and register variation in

the production of the sequence consonant plus high-mid front vowel in word-final syllables in BP. Dialectal features and speech rate, mainly, account for productions varying from [e] to [ɪ], or [i], and for vowel devoicing or even omission. The physical presence or absence of the vowel in this context is completely irrelevant, so that variation does not impede the recognition of the sequence as a realization of the prototype CV syllable.

The ability to recognize L1 prototypes in spite of variation may lead to the perception of an L2 sound, or sequence of sounds, as within the array of L1 variation, and consequently, to classify it as a representative of the L1 prototype. In this sense, since the basic syllabic prototype pattern of BP is the CV, L2 ##CVC## input might be interpreted as ##CVCV##, which would conform to this pattern, where the final vowel carries the irrelevant allophonic variation of the L1.

This seems to have been the case in the performance of the group of L2 learners investigated here, characterizing perceptual foreign accent. The CV mental representation, deeply rooted by long experience in the monolingual environment (Flege, 1995, and elsewhere) together with the lack of relevance of the physical presence or absence of the vowel for the sequence to be perceived as CV, seems to have led the participants, adult BP speakers, to perceive ##CVC## words as ##CVCV## even when the [i] was not realized.

There has been research (see Section 4.4) indicating that L2 speakers of different L1s tend to rely on different representational levels, according to the characteristics of their L1s. In contrast with the view of a universal unit of speech perception, it seems to be the case that both the nature and the operation of different levels of representations vary according to the specificities of the languages in contact and according to the target sound(s) in question. As observed by Baptista, speakers may have a repertoire of mental representations comprising units at different linguistic levels – at the level of the

segments or sequences of segments (the syllable, the onset, or the coda) (B. Baptista, personal communication, June, 2001).

In opposition to the view that speech sound mental representations are restricted to the segmental level, data from studies such as the present one may contribute to the discussion of claims that the perceptual encoding of the L2 final consonant conforms to the CV syllable prototype for BP speakers.

When the production and perception pictures taken by this study are juxtaposed, an association appears between the two images, indicating that degrees of variation in the perception and production performance of the group investigated can be noted, where as production becomes more accurate, perception also tends to improve, or the other way round. What must be noted is that associations of the type identified in the present study inform about the strength of the relationship, and as such, may help to delineate developmental behavior; however, they leave open important questions about the nature of the relationship. As pointed out in Section 4.5, three hypotheses concerning the direction of the relationship between L2 speech perception and production have yielded conflicting results – that perception precedes production, that the two abilities develop simultaneously, and that production precedes perception.

It is hoped that this study has contributed to the discussion with data from adult beginning L2 learners, indicating a certain degree of alignment of the two abilities.

6.4.2 Variable of markedness

Voicing of the target consonant – HYPOTHESIS 7

Hypothesis 7 predicted that participants would discriminate more ##CVC## and

##CVCV## sequences where the final vowel was an /i/ if the target consonant (the second consonant) was voiceless than if it was voiced. The question of an influence of markedness in terms of voicing of the target consonant in the discrimination of these sequences was investigated in order to provide speech perception data to be compared to the production data analyzed in the investigation of Hypothesis 1. The variable involved in this examination was the rate of correct discrimination in the different trials by subject for each target. As in the investigation of Hypothesis 1, concerning the speech production test, 5 pairs of data were investigated here: /b/ - /p/, /d/ - /t/, /g/ - /k/, /v/ - /f/, and /dʒ/ - /tʃ/. Table 6.9 shows the overall rates of discrimination for each voicing pair:

Table 6.9

Rates of discrimination by voiced/voiceless pairs

		Bilabial Stops	Alveolar Stops	Velar Stops	L-dental Fricatives	Alveopal. Affricates	Total
N° Trials	[-vd]	60	100	80	60	60	360
N° Discr	[-vd]	14	33	16	16	22	101
% Discr	[-vd]	**23.33%**	**33%**	**20%**	**26.66%**	**36.66%**	**28.05%**
N° Trials	[+vd]	40	60	60	60	60	280
N° Discrim	[+vd]	12	17	21	8	14	72
% Discr	[+vd]	**30%**	**28.33%**	**35%**	**13.33%**	**23.33%**	**25.71%**
Tot N° Trials		100	160	140	120	120	640
Tot N° Discr		26	50	37	24	36	173
Total %		**26%**	**31.25%**	**26.42%**	**20%**	**30%**	**27.03%**

The statistical analysis, performed on the rates of discrimination by subject between the voicing pairs yielded the following results with paired-samples *t*-tests, where only the difference for labiodental fricatives was significant ($p < .05$): for bilabial stops, $t = -1.22$; for alveolar stops, $t = .71$; for velar stops, $t = -2.08$; for labiodental fricatives, $t = 2.17$, $p < .05$; and for alveopalatal fricatives, $t = 1.79$. The non-parametric Wilcoxon signed ranks tests yielded the following results, where the difference for velar

stops and the difference for labiodental fricatives were significant ($p < .05$) : for bilabial stops, z = -.96; for alveolar stops, z = -.70; for velar stops, z = -2.01, $p < .05$; for labiodental fricatives, z = -1.99, $p < .05$; and for alveopalatal fricatives, z = -1.66.

Thus, the difference between rates of discrimination for voiceless and voiced labiodental fricatives was significant with both tests, and in the expected direction. For the velar stops, the difference was very close to significance level with the parametric test (p =.051), and reached significance with the non-parametric test, but it was the voiced pair that was more frequently discriminated – opposite to the expectation.

These results can be analyzed in two ways: in terms of Hypothesis 7 and in terms of the results of the production test (Hypothesis 1).

As can be seen in Table 6.9, of the five pairs analyzed, three yielded overall results in the direction of the expectations, that is, higher rates of discrimination for the voiceless targets – the alveolar stops, the labio-dental fricatives, and the alveopalatal affricates. The statistical procedures revealed that among these pairs, only the difference between voiced and voiceless labio-dental fricatives was statistically significant. In fact, the overall rate of discrimination for the voiceless fricative was twice the rate for the voiced. The total rate of discrimination for the voiceless targets was somewhat higher than for the voiced targets as well.

When analyzed in terms of the outcomes of the speech production test, the results of the perception test show that there was an inverse relation between perception and production for bilabial and alveolar stops, alveopalatal affricates, and for the total of voiced and voiceless targets. In other words, in these four pairs if the higher rate of discrimination was for the voiceless target/ś, the higher rate of epenthesis was for the voiced one/s, or the reverse. The two deviations of this pattern of inversion were for velar stops and labio-dental fricatives; that is, in these two pairs the higher rate of

discrimination coincided with the higher rate of production of epenthesis. Two of the inverse-relation pairs yielded results in the direction of the hypothesis – the alveolar stops and the alveopalatal affricates. Although in none of the four pairs bearing the inverse relation the difference reached statistical significance, in the two exceptions (the coinciding perception and production higher rates) the difference was significant.

Thus, in terms of establishing a relationship between perception and production, the overall tendency in the results indicates that in fact, there seems to be a relationship between the discrimination of ##CVC## and ##CVCV## sequences and production of epenthesis, as the correlation tests carried out for the investigation of Hypothesis 6 show. However, the analysis of the relationship in terms of markedness by voicing does not seem to be very revealing since it is hard to detect any clear tendency in this sense.

6.4.3 Variable of phonological environment

Strength relations across syllables – HYPOTHESIS 8

In parallel with Hypothesis 5, Hypothesis 8 predicted that the greater the difference in consonantal strength between the target and the context consonant, the lower the rates of discrimination of ##CVC## and ##CVCV## sequences would be (strength relations established according to the description in Section 5.7.1). The variable investigated was the rate of correct discrimination in the different trials by subject for each SCN. Table 6.9 shows the rates of discrimination for each SCN:

Table 6.10

Rates of discrimination by syllable contact number (SCN)

SCN	-3	-2	-1	0	1	2	3	4	5	6
N° Trials	60	60	80	100	60	40	80	40	40	20
Correct Discr	24	22	20	34	14	13	21	10	7	12
% Discr	**40.00**	**36.66**	**25.00**	**34.00**	**23.33**	**32.5**	**26.25**	**25.00**	**17.50**	**60.00**

The *t*-tests and Wilcoxon tests on rates of discrimination by subject for each SCN 'pair' in the sequence yielded the following results, where the only statistically significant difference ($p < .05$) was for the (-2)-(-1) pair:

Table 6.11

Values of the differences for each SCN 'pair' with the Paired-Sample t-Tests and with the Wilcoxon Signed-Ranks Test

SCN	(-3)-(-2)	(-2)-(-1)	(-1)-(0)	(0)-(1)	(1)-(2)	(2)-(3)	(3)-(4)	(4)-(5)	(5)-(6)
t	.43	2.69	1.92	1.55	-1.33	.86	.19	-1.13	.25
z	-.46	-2.28	-1.67	-1.61	-1.27	-.79	-.18	-.85	-.49

It is hard to identify any specific reason, in the nature of the targets and contexts involved, for the fact that, among all SCN pairs, only the differences in the discrimination rates for SCNs (-2) and (-1) reached statistical significance.

Analysis of the results displayed in both Table 6.10 and Table 6.6, reporting SCN data on perception and production tests, shows tendencies in the expected directions (with some deviations) in both cases. Thus, as SCN increases, epenthesis production also increases and discrimination between ##CVC## and ##CVCV## sequences (perception) decreases. Although in both cases the tendencies are not marked, and as such, in general did not yield statistically significant results, the coincidental overall tendency must be interpreted as signaling some support for the perception-production relationship.

The analysis of the association between SCN and discrimination rates yielded the following results: with the Pearson Product Moment Coefficient of Correlation, $r = .04$,

and with Spearman's Rank Order Correlation, *rho* = -.25, both correlations non-significant at the .05 level. The inspection of the joint distribution of discrimination rates and SCN indicated the presence of an outlier, which was identified as the participant whose rate of discrimination fell more than 3 standard deviations from the mean. In the analysis without this outlier the association was in the expected direction and reached significance with both tests (r = -.78, p = .007, and *rho* = -.72, p = .013). Thus, both the production and the perception data concerning SCN show tendencies in the direction of the hypotheses (5 and 8).

The analysis by sets of data, making three groups – negative SCNs, SCN (0), and positive SCNs – also allowed for a parallel between the perception and production results. This analysis yielded the following results: for the set of negative SCNs, the overall rate of discrimination was 33%, for SCN (0), it was 34%, and for the set of positive SCNs it was 27%. Recalling that epenthesis rates in this type of analysis were 43.38%, 43.69%, and 44.48%, respectively, comparison between the results of the two tests shows that whereas there was a slight increase from the set of negative SCNs, to SCN (0), then to the set of positive SCNs in the production test, there was a decrease in the discrimination rates in this direction, with a slight deviation in the rate for SCN (0). In fact, the difference between the rate for SCN (0) and for the set of negative SCNs is very small in both tests, which may be taken to indicate support for Hooper's (1976) principle of strength relation across syllables (SSC) later developed into the Syllable Contact Law (SCL) by Murray and Vennemann (1983) proposing that problems may arise when in a situation of syllabic contact the strength of the second consonant exceeds the strength of the first (see Section 2.3).

6. 5 Summary and final comments about the results

The results of the statistical analyses performed on data from the production and perception tests showed that, in most cases, the differences between rates of epenthesis and between discrimination rates investigating variables of **markedness** and **phonological environment** were not significant, so that the hypotheses predicting effect of these variables could not be statistically supported. However, the analysis of the results computing the overall rates, taken together with results from previous research, may signal some tendencies.

A look through the tables showing overall rates evinces the fact that, with a few exceptions, there was an accentuated balance in the rates computed in the analyses of the markedness and phonological environment variables in both the production and perception data.

The overall rate of epenthesis production in the reading test was 44.45%, contrasting with the 15.2% rate found by Baptista and Silva Filho (1997), using the same type of material and procedures for gathering data. There seem to be two possible reasons for this accentuated difference: the first, and most likely, is the level of English proficiency of the students participating in the two experiments. Whereas the previous study lumped together data from students in the first, second, and eighth semesters of foreign language instruction, the participants of the present study were only in the first and second semesters. The second reason is the different judgment criteria and procedures employed in the two studies. Whereas in the earlier study epenthesis production was judged by an experienced nonnative teacher of English as a foreign language used to Brazilian students' pronunciation, who heard the stimuli from a cassette tape recorder, in the present study the three native judges were almost

completely 'naïve' in terms of contact with non-native English pronunciation, and rated the stimuli as heard from a computer in a sound booth. Attentional capacity is clearly different in the two procedures.

Regarding the variables investigated, **markedness relations** were expected to affect **epenthesis production** in the line of the predictions made by the MDH (Eckman, 1977/1987a) (see Section 3.2.1). One of the objectives of this study was to examine whether the results of Baptista and Silva Filho (1997) concerning the MDH would be reproduced here. The authors found an effect of markedness in terms of the influence of voicing and place of articulation of the target consonant and an effect of markedness interacting with NL transfer in the analysis of the influence of classes of obstruents. The interacting results were interpreted as indication that investigations based on the predictions of the MDH have to give space to considerations about the potential for transfer inherent to the linguistic structure under examination.

It must be borne in mind that statistical analysis was not carried out in Baptista and Silva Filho, and in the present study this analysis showed that the differences in markedness relations were not significant. However, considering the possibility that the results of these two studies, taken together, indicate probable tendencies seems valid in face of the points they have in common – the population tested, and the material and procedures employed.

Analysis of the results of **Hypothesis 1** in terms of tendencies, in comparison with Baptista and Silva Filho's results, showed that in both studies most voiced targets caused more epenthesis than their voiceless counterparts, and that the two classes of obstruents not conforming to this tendency were the same in both studies as well – bilabial stops and labio-dental fricatives. The nature of the consonants involved in these two deviant outcomes can be linked to research by Yavas (1994, 1997), indicating an

effect of aerodynamic features on the production of stops. In fact, analysis of the data investigating specifically Yavas's (1994) claim (**Hypothesis 3**) yielded results corroborating Baptista and Silva Filho's as well. These coincidences may be taken to signal a potential area for future research on markedness relations.

The other aspect of markedness investigated in the production test here – effect of manner of articulation (**Hypothesis 2**) – showed tendencies contradicting the hypothesis based on Eckman and Iverson (1994) that affricates would cause more epenthesis than fricatives, which in turn would cause more epenthesis than stops, a tendency corroborated by Baptista and Silva Filho's results. In conformity with Tropf (1987), and with Hooper's (1976) and other sonority or strength hierarchies, an inverse tendency to that of the hypothesis for fricatives and stops was detected here. It must be noted that the difference between the two rates is quite small and as such may not even characterize a tendency; however it at least shows that the hypothesized direction was not borne out with the data of this study. The total lack of definition concerning sonority or strength relations apparent both in the conflicting results of the few studies investigating the issue and in the status given to stops, fricatives, and affricates in the hierarchies points to the need for research in the area. Cross-language research has a crucial importance in the search for the definition of a universal sonority hierarchy, an ambitious project, indubitably. Even if this research is unsuccessful, the analysis of different language contact situations in terms of sonority relations will certainly reveal relevant data about the languages themselves and about the specificities of the contact situations in question.

The investigation of **markedness relations** concerning **perception** aimed at examining the effect of voicing of the target consonant on perceptual performance (**Hypothesis 7**) so that a parallel with production performance (**Hypothesis 1**) could be

drawn. This comparison did not reveal any well-defined tendency. The results of the production test in terms of the tendency shown here and in Baptista and Silva Filho for greater accuracy with labial consonants, taken together with the lack of any detectable influence of voicing in the discrimination of the sequences, seem to indicate that differential production performance concerning the voicing distinction is more related to articulatory difficulties than to perceptual factors. For the time being, the mystery remains.

The second type of linguistic variable examined was **phonological environment**. First, phonological environment or context was expected to affect **epenthesis production** in terms of a consonant, a vowel, or silence (**Hypothesis 4**), in the line of the investigations by Carlisle (2001, and elsewhere) who set the field dealing with epenthesis production in /sC(C)/ clusters. Baptista and Silva Filho's was the pioneer study on final-consonant epenthesis production controlling the environment in these terms. On the whole, the results of the studies focusing on the influence of phonological context, taken together, reveal a lack of consistency, and comparing the results of the present study with those of Baptista and Silva Filho add to the blurred picture. Whereas in their study epenthesis rates increased from silence, to vowels, and then consonants, in the present study, they increased from consonants, to pause, then vowels. Again, recall that Baptista and Silva Filho did not apply statistical analysis to their data, and the data in the present study showed no statistically significant difference between the rates for each context 'pair'. The controversial outcomes are intriguing. They seem to indicate that phonological context in terms of a consonant, a vowel or silence may operate in interaction with other variables that need to be investigated in strictly controlled projects.

The second aspect of **phonological environment** investigated in relation to **epenthesis production** was the effect of sonority or strength differences across

syllables (**Hypothesis 5**). The base for this line of investigation was Hooper's (1976) Syllable Structure Condition (SSC), and Murray and Vennemann's (1983) extension of the SSC formulated as the Syllable Contact Law (SCL). The former proposes a preferred strength (sonority) condition for syllable contacts, where the final consonant is weaker than the first consonant of the following syllable, and the latter proposes gradual increase of difficulty with the value of the strength difference between the marginal segments (see Section 2.3). Comparison of the results of the present study to those of Baptista and Silva Filho shows that (with some deviations in both cases) a tendency in the expected direction, that is, for epenthesis rates to increase from the lowest SCN to the highest can be identified. Also, another coincidental pattern of results could be identified in the two studies through analysis of the data in terms of three sets: negative SCNs, SCN (0), and positive SCNs. In both cases, results were in the direction of the hypothesis, revealing data to corroborate the principle of the SSC.

The investigation of **phonological environment** concerning **perception**, aimed at examining the effect of the variable on perceptual performance (**Hypothesis 8**) so that a parallel with production performance (**Hypothesis 5**) could be drawn. Only one of the SCN 'pairs' in the sequence – (-2)-(-1) – yielded statistically significant results in the difference between the rates of discrimination in the tokens comprised in each number, and no reason could be identified for the exception.

However, the pattern of results obtained in the production test (**Hypothesis 5**) was repeated here; that is, a tendency (also with some deviations) in the expected direction occurred in the discrimination rates for individual SCNs and in the analysis of the three sets of SCNs: negative, (0), and positive. Both tendencies were, as expected, in the inverse direction of the that for epenthesis production, characterizing a relationship, though a weak one, between the two abilities.

Besides the examinations of markedness relations and phonological environment, the **relationship between perception and production** was investigated in terms of rates of epenthesis production and discrimination scores of the sequences ##CVC## and ##CVCV##. As predicted in **Hypothesis 6**, a negative association between the two variables was shown in the statistical analysis. The correlation tests showed that the initial weak correlation found with the whole group, increased and reached significance in the analysis without the two outliers identified in the data.

Both the general high rates of epenthesis (as mentioned above) and the low discrimination scores obtained depicted participants' low proficiency in the foreign language. The association between perception and production at this early stage of L2 phonological acquisition seems to be quite aligned. Not only is production shown to be notably molded by the L1 norm, deviant from the L2, but perception also seems to rely strongly on a L1 structure different from that of the L2, characterizing foreign accent in both skills.

CHAPTER 7

CONCLUSION

7.1 Theoretical implications

The objectives of this dissertation were to re-examine the variables investigated in Baptista and Silva Filho's (1997) study to see if the same outcomes would be obtained in a replication with a larger group of subjects, and to investigate the relationship between perception and production in vowel epenthesis following word-final single-consonant codas. The variables from Baptista and Silva Filho which were re-examined here were (a) voicing of the target consonant, (b) relative markedness within the class of obstruents, (c) relative markedness among voiced stops by place of articulation, (d) phonological contexts as consonants, vowels, or silence, and (e) sonority relations across syllables.

The variables in the assessment of perception and of the perception-production relationship were (a) markedness – voicing of the target consonant, (b) phonological environment – sonority relations across syllables, and (c) the general relationship between the two abilities, investigation the degree of association between epenthesis production in the sentence reading test and perception of the difference between sequences ##CVC## and ##CVCV## where the final vowel was /i/.

Following Baptista and Silva Filho, the investigation of markedness relations in this study is underpinned on previous research and theoretical developments of Eckman (1977/1987a, 1991), Eckman and Iverson (1994), and Yavas (1994, 1997). Eckman's Markedness Differential Hypothesis (MDH) proposes that L2 structures that are both

different and more marked than those of the LI are difficult to acquire, and that the degree of difficulty depends on the degree of markedness. Taking the predictions of the hypothesis, it is expected that the acquisition of English final consonants by BP learners is not only problematic, since it is a marked structure not present in the L1, but is also affected by markedness relations among the L2 consonants. Later, in his Structural Conformity Hypothesis (SCH), Eckman (1991) proposes that, as linguistic systems, interlanguages are characterized by the same universal generalizations that hold for the world's primary languages. In this sense, markedness relations in terms of voicing are expected to affect interlanguage production in the same way that their influence on primary languages has been attested. In the case of the final consonant, voiced consonants, being more marked than voiceless consonants in the world's languages, are expected to be more problematic in IL production as well.

Eckman and Iverson's (1994) contribution to the field was given by a study investigating effect of markedness in terms of sonority relations in L2 production of syllable-final consonants. The markedness ranking proposed by the authors for affricates, fricatives and stops (markedness diminishing from left to right in this order) contrasts with the ranking of sonority relations among the three classes of obstruents proposed in most sonority hierarchies in the literature, among them Hooper's (1976) and Selkirk's (1982), which are two of the most frequently cited. In these hierarchies, sonority increases from affricates to stops, and then fricatives.

Yavas (1994, 1997) contributed with another approach to markedness effects on L2 final consonant production. Based on his study of final consonant devoicing, propositions of differential performance, in the production of the final consonants can be made considering place of articulation in terms of difficulties posited by velars, alveolars and labials.

Also in the line of Baptista and Silva Filho (1997), the investigation of the influence of the phonological environment in this study is underpinned on previous research and theoretical developments of Carlisle (2001, and elsewhere), Hooper (1976), and Murray and Vennemann (1983).

Carlisle's research on vowel epenthesis production in initial /sC(C)/ clusters has shown an effect of the preceding phonological environment in terms of consonants or vowels. In his study of 1992, the author pointed out an interaction between markedness of the target sequence and phonological context affecting cluster production, which seems to have led him later (1994) to consider the influence of markedness relations within the phonological environments themselves.

Hooper's (1976) Syllable Structure Condition (SSC), postulating a universal preference for syllable contacts where the syllable–initial consonant is stronger (less sonorant) than the preceding final-syllable consonant, and Murray and Vennemann's (1983) Syllable Contact Law (SCL), incorporating relative strength conditions to Hooper's proposal, established the framework for research examining effect of sonority relations in syllable contacts.

As reported in the previous chapter, the results of the present study did not provide statistical support for the hypotheses of markedness and phonological environment based on the theoretical proposals and research mentioned above. However, two interesting coincidences in terms of tendencies apparent in Baptista and Silva Filho and in this study might be taken as pointing at potential implications for the corresponding theories.

First, the coincidence in the two studies in terms of the tendency shown in the differential production of labial consonants may be taken to indicate that Yavas's (1994) claim for markedness by place of articulation points to where universal markedness relations as proposed by Eckman's MDH exert a relevant influence in the production of

the final consonant. The interaction shown in Baptista and Silva Filho between universal markedness relations and L1 transfer, taken together with the lack of effect of markedness and the high rate of epenthesis overall in the present study, seems to indicate that the MDH needs to be taken with caution, opening space for consideration of the possibility that L1/L2 differences might overrule the influence of universal markedness relations in some cases.

The second coincidence accounts for the effect of sonority relations across syllables. Both studies revealed slight tendencies in the direction of the postulates of the SCL (in the present study also in terms of perception). The analysis by sets of data contrasting negative to positive SCN reinforce the impression that the parameters established in both Hopper's SSC and Murray and Vennemann's SCL are effective tools in accounting for IL syllabic contact variation.

Besides these two coincidences, the conflicting results in the investigation of markedness relations within the class of obstruents, and the identified tendency for production and perception to be affected by sonority relations across syllables, taken together with the lack of agreement in the literature about (a) a satisfactory phonetic or phonological definition of sonority, (b) the ranking of obstruents in the different hierarchies, and (c) the status of voicing in the these hierarchies, argue for urgency in sharpening the concept of sonority as a primordial condition for progress in the field. The establishment of a universal hierarchy does not seem possible without thorough descriptions of the sonority relations inherent to different languages. However, in order for these descriptions to provide comparable data, they must be underpinned on common patterns of conceptualization of the features involved. The relationship between markedness and sonority, pointed out in the literature as an obscure area in itself, also requires that the concept of sonority be formulated in more consistent terms.

The results of this study corroborate Hooper's (1976) ranking for fricatives and stops, and they show that the discussion about affricates may be more complex than Hooper suggests. The lower rates for affricates (than fricatives and stops), shown in the present study, signal an area where future studies may contribute largely to the discussion of sonority relations. Since affricates share features of both fricatives and stops, the least sonorant classes, two possibilities seem reasonable in a simplistic analysis – that they may be at an intermediate rank, by sharing the features of these two classes, or that they may be the least sonorant class by adding the features of both. Whereas Hooper opts for the second interpretation, the hierarchy proposed by Dziubalska-Kolaczyk (1997) supports the first. Mixed results from studies up to the present time do not allow a strong claim for either. Instead, they show that this is an area for further careful investigations.

The investigation of the relationship between perception and production was carried out based on the lines of work of Flege (1995, and elsewhere), with the objective of providing insight into both the relationship between perception and production in vowel epenthesis following word-final single-consonant codas, and the discussion of the status of the syllable as a possible unit of perceptual analysis to which BP speakers resort in dealing with the L2 sound in this context.

The universe of speech perception is fascinatingly intricate, and only very recently have technological and methodological developments in general begun to provide a means for investigations of the mysteries that go on in the speaker's mind in the processing of the speech signal input. Both clinical research and cross-language research are expected to give crucial insights into perceptual learning as a whole, and to contribute to further develop perceptual theory.

Cross-language speech research has yielded results that are interpreted as pointing

in three directions: that perception precedes production, that the two abilities develop concomitantly, and that production precedes perception. These hypotheses are of unquestionable importance to the field.

Without going deep into the issue, owing to the complexities described above, the interpretation that production precedes perception seems to be unreasonable. It does not seem possible that production performance, in any case, can be dissociated from perceptual intake. In fact, it seems improbable that a claim for production preceding perception would find support in any theory of perception. What must be borne in mind is that perception and awareness are not synonyms, in the first place, and that productive behavior has to be construed on some kind of internalized information, that is the perception of that item, whatever form it takes (auditory, proprioceptive, visual) and regardless of the degree of awareness the perceiver has about what is perceived. The degree to which production corresponds to perception may be affected by a number of factors inherent to the productive behavior itself, such as the articulatory complexity of the sound in question. In fact, the literature reports on studies where production outperformed perception; however, as Flege (1991) comments in relation to Sheldon and Strange's (1982) study with Japanese students' production and perception of /r/ and /l/, this pattern of results seems to be a factor of methodological procedures. That is, the fact that in a determined testing situation production outcomes are shown to be more positive than perception outcomes does not mean that production of the segment/structure in question precedes perception of that item.

It seems more plausible that the relationship must be seen and investigated from the point of view that perception precedes production; however production does not always reflect perceptual performance. Thus, a shift in the perspective on which investigations of the perception-production relationship are carried out would focus the

issue from the point of view of 3 main questions: (a) whether or not a particular production performance is founded on perceptual factors, (b) whether or not perceptual improvement has a direct effect on production performance, and (c) whether or not perception performance can be enhanced by training.

As to the discussion concerning the unit of speech representation, Flege's Speech Learning Model (SLM) makes predictions about L2 phonological acquisition in terms of segments, whereas this study deals with syllable structure and the presence or absence of an additional phone, investigating the possibility that mental representations of speech sounds are also construed on larger dimensions. Results of studies such as the present one, indicating that L2 speakers rely on the L1 syllabic pattern representation in dealing with structures that conflict with this pattern have implications for the extension of the SLM to incorporate units larger than the segment into the model. Among the hypotheses of the model, the identification of perceptual procedures relying on syllabic representation has implications for H1, predicting position-sensitive allophonic perception. It seems that the hypothesis could be reformulated to incorporate the phonotactic sensitivity (or lack of it) attested in language contacts where an L2 sound structure does not occur in the L1, as in the case of the English final consonant for BP speakers.

7.2 Pedagogical implications

As a cognitive skill, L2 acquisition is studied today in a context where the discussions are sustained by theoretical and empirical developments in the area of information processing theory, and, more specifically, by empirical data on the mental processes involved in linguistic information storage and retrieval. In this context, it is

primordial to take into account fundamental aspects in the structuring of linguistic representations, such as the processes through which this structuring occurs, the form in which linguistic representations are stored, and the conditions and forms in which these representations become performance.

In the SLM, Flege (1995) makes predictions about the processes through which L2 speech sound representations are built. Flege argues that a great deal of the pronunciation problems are due to deviant perceptual targets guiding the sensory-motor learning of the sounds. Independently of the nature that speech sound representations may assume (proprioceptive, acoustic, or the combination of both) whereas the L1 sounds are acquired procedurally, in L2 acquisition posterior to the period when the L1 becomes systematized, that is, after literacy acquisition takes place, L1 speech sound representations operate as a referential on which speakers rely, establishing associations through the process of equivalence classification. Major (1994) says that there are, basically, three possibilities: (a) the representation may be identical to that of the native speakers; (b) may be a representation of the L1; or (c) an intermediate representation. Flege (1991) classifies this intermediate representation as a 'merger', that is, an L2 sound perceived as similar to an L1. In this sense, a primordial step in the process of L2 speech sound acquisition is for the speaker to build up genuine L2 representations, breaking up the perceptual, motor, psychological, cognitive and socio-cultural parameters of the L1, and building up a new system of parameters from the L2 stimuli.

It is important to notice that in the process of equivalence classification, the system that was acquired as procedural knowledge is available as schemata, that is, declarative knowledge. This view goes in the direction of Færch and Kasper's (1986) definition of IL processes as part of the speaker's procedural knowledge working on his/her declarative knowledge. In this sense, problems arise when the two systems (L1

and L2) conflict, and the referential system gives the speaker inappropriate perceptual cues on which the L2 representations are built.

The results of the present study might characterize this situation. The group of learners investigated seemed to lack the appropriate cues on which to build up perception and production of the word-final consonant. Their production deviated markedly from the L2 norm, approximating the contrasting L1 norm, and their perception of a related L2 relevant (and L1 irrelevant) contrast was extremely weak, that is, these perceivers could not pick up the L2 distinctive cues because in the activated schemata, that of the L1, the distinction was not critical.

Pedagogically speaking, the results of the present study indicate that these learners need substantial help in order to modify the status quo, and two basic questions arise: what and how this help may be provided.

As to the first question, if their perception and production of the word-final consonant is taken as a measure of overall performance in the L2, that is, as depicting the degree of overall perceptual and productive, the answer is that they need all kinds of help: they need L2 input, both qualitative and quantitative, they need to establish contact with the language in the first place, so that the new schemata begin to build as a whole. Focusing on the problem detected by the experiment, the L2 input needs to provide the specific cues that these learners were shown to lack – the critical distinction between an obstruent plus /i/ sequence versus a single obstruent.

There is remarkable consensus today that any teaching/learning situation should take advantage of what is likely to be more easily assimilated, that is, the point of departure should be the less problematic item. Although, in face of the lack of statistical support, the results of the present study cannot be taken to make claims for one or another teaching sequence in terms of the linguistic variables investigated, seen in

conjunction with the results of previous research, two points can be made: First, considering the tendencies detected in the investigation of Hypothesis 1 and 3, preference should be given to labials, followed by alveolars, and then velars. Second, considering the results of the investigation of sonority relations across syllables, both in the perception test and in the production test, it seems that sequences resulting in lower SCN should be taught before the ones bearing higher SCNs.

Indubitably, the most evident teaching implication suggested by the results is the need to focus seriously on perceptual performance, and this leads to the second pedagogical question – how these learners can be helped.

The issue of teaching pronunciation is controversial. Historically it has been treated with irregularity in foreign language teaching methodologies (see Celce-Murcia, Brinton & Goodwin, 1996). To begin with, there seems to be a great discomfort in dealing with pronunciation in terms of 'teaching', so that preference is given to the term 'training' in the literature. What could seem, at first sight, a mere question of terminology, in fact reflects a challenging discussion of the approach given to the exploration of the ability in instructional settings – more specifically, about the use of formal instruction.

Resistance until recently to pronunciation 'teaching' was probably a natural consequence of a long and unsuccessful experience with mechanical drilling. In times of urgency in communication, and after all the developments made by science in the field of human cognition, it became unacceptable for L2 practice to be done through de-contextualized, or even nonsense language for the sake of accuracy.

The situation, nowadays, seems to have changed, though. In fact, after a period of exacerbated aversion to bringing to the classroom any type of activity that could give the slightest idea of formal instruction in L2, which many times led to indiscriminate

rejection of systematization, explicitation, to the act of 'teaching', today there is a considerable variety of materials available in which pronunciation is approached in a communicative way, but also in a way which provides opportunity for focused training as an additional methodological resource. However, the question of the potential of explicit instruction, focused training, or both in providing for genuine changes in pronunciation performance is open to investigation.

The literature is rich in arguments against pronunciation teaching in general. In the center of the discussion about the most efficient methodology in pronunciation acquisition and development is the question of the relationship between declarative and procedural knowledge. The main polemical issue concerns the question of whether metalinguistic knowledge can gradually be automatized becoming procedural knowledge. Paradis (1994) says that according to Parkins (1990), some tasks deliberately learned seem to become gradually automatized through prolonged practice. However, it is important to notice that what automatizes the tasks is the practice per se, not knowledge about the procedures. As the task is practiced, automatization develops. Thus, if the procedure practiced deviates from the declarative knowledge that the individual has about the procedure, it is the procedure that becomes automatized. Access to declarative knowledge may, indubitably, raise awareness of a deviant procedure and help to promote remedial measures. The independence of the two knowledge systems does not mean that they cannot interact, complement, and inform each other.

In situations of L2 acquisition in instructional settings, where the amount of exposure and practice is very restricted, the probability that the procedural stimuli provides substantial enough material to enable learners to build up the appropriate representations may be very low. Although every effort should be made to provide the

critical amount of language exposure (by any means), the cognitive and emotional baggage the post-literacy learner brings to the classroom puts him/her in a situation very different from that of the linguistically naive child acquiring L1.

The necessity of contact with authentic L2 stimuli and of extensive communicative practice in pronunciation is unquestionable. However, it is fundamental that this practice be the practice of accurate targets. The practice of deviant targets, judged as satisfactory from the perspective of inaccurate mental representations will eventually automatize gestural routines leading to fossilization, that is, deviant pronunciation highly resistant to modification (Selinker, 1972). Explicit information may have an important role in the construction of L2 mental representations and help to trigger effective practice.

It is up to the materials writers and, of course, the teachers to make resources available so that these learners take advantage of background knowledge, reverting the situation positively.

7.3 Limitations and suggestions for further research

In general, during the process of data analysis, several limitations of research projects emerge, mainly in terms of the inability of the data collected to answer questions triggered by the pattern of results obtained.

In the present study, two main limitations were identified. The first limitation is, indubitably, the participants' low level of proficiency in English. Owing to this, the results must be seen as applying to a very particular population sample – adult L2 learners, pedagogically characterized as 'false-beginners' owing to previous experience in high school, where exploration of the written language is highly prevalent, and to very little experience in a language course. In fact, this restricted scope in terms of

generalizability of the results to a larger population of learners is, on one hand a limitation, and on the other hand, an advantage of the study. Strict care was taken to ensure the homogeneity of the group in terms of L2 experience, so that, for example, participants who shared all the characteristics but reported greater contact with music in English (by trying to sing or write the lyrics) were not included in the sample. The advantage of this homogeneity and focus on such an initial stage of learning is that it allows for comparison with groups varying in a wide range of aspects.

Suggestions to overcome this limitation are, obviously, in terms of projects including different levels of proficiency, and of longitudinal studies. In the case of the present group of participants, subsequent tests would bring revealing data to be added to the discussion of age-related constraints in L2 acquisition. Since in non-natural L2 learning environments it is possible to control for variables that might interact with age in speech acquisition in natural settings, such as amount of L1/L2 activation and socio-cultural pressure, longitudinal studies carried out in instructional settings are a valid reference for the discussion.

The second important limitation is related to the amplitude of the study. Owing to the number of variables investigated, it was not possible to strictly control the stimuli for eliciting balanced and substantial data for all the variables investigated. This could be noticed particularly in terms of the variables involved in the investigation of Hypothesis 5 of speech production and in Hypotheses 7 and 8 investigating speech perception. In the case of Hypotheses 5 and 8, examining SCN and rates of production and perception data, the imbalance in the number of tokens for each SCN can be seen in Tables 6.6 and 6.10. Although this imbalance did not seem to have affected the statistical analysis, more uniform data could have shown more marked tendencies.

Specifically in the case of the perception test, the inclusion of more tokens for

each SCN (Hypothesis 8), for more voicing contrast pairs (Hypothesis 7), or for both would have made the test too long. The design of the test involves, besides the linguistic variables, the control for test variables such as position and structure of the odd item; thus the number of language contrasts included triggers a snowball effect in order to keep the balance in the test variables as well. Since speech perception tests involve important factors related to information processing, limiting the length of such tests is crucial for the reliability of the data gathered.

Suggestions in terms of this limitation are for independent research projects concentrating on specific aspects investigated in each hypothesis of the present study so that more control can be applied to the stimuli and more balanced data can be collected. Since the investigation of the perception–production relationship comprises, in itself, two sets of linguistic variables that have to be in complete harmony to allow for association, any variation in one testing mode implies variation in the other mode.

In terms of independent research projects, both the contrasts and shared tendencies of Baptista and Silva Filho (1997) and the present research signal that each of the research questions on linguistic constraints seems to merit examination through longitudinal studies focusing on perception and production behavior. The conflicting results of Rebello (1997) and Carlisle (2001, and elsewhere) reinforce the need for studies concentrating on specific aspects of markedness and phonological environment so that the control of linguistic constraints can neutralize the influence of intervening variables.

Suggestions for further possibilities of research focusing on L2 word-final consonant perception and production can be given in terms of the following projects: First, a research project could investigate the effect of orthography, where stimuli for /s/, /z/, /m/, and /n/ are examined in two types of target words – those spelled with a final consonant and those spelled with the consonant followed by 'e'. A second research project could

investigate the effect of L1 dialect in terms of the realization of the final high-mid vowel in L1 words, and of the realization of alveolars. As mentioned before, the pronunciation of the final high-mid vowel in BP varies dialectally from /e/ to /i/ and this variation has marked influence in the epenthetic vowel added to the final consonant of loanwords and acronyms and, in some cases, in breaking up consonant clusters within loanwords as well. Concerning alveolars, dialectal variation operates in terms of palatalization, which seems to have a devoicing effect on the final vowel. Data on L2 behavior contrasting performance of different dialect groups may provide interesting information about L1 interference on both perception ad production. A third research project could investigate the effect of self-perception on production, in the line of Baker and Trofimovich's (2001) study, which indicated that self-perception played a role in L2 production. A fourth study, could be carried out on the effect of perception of accent on epenthesis production (accented pronunciation characterized in terms of epenthesis production, in general terms, or in both), where stimuli from a group of BP speakers with different degrees of accent in English are judged by another group of BP speakers for accent.

Finally, a fruitful area open to a number of possibilities concerns the investigation of the effect of training on perception and production. These studies are of invaluable importance for the improvement of teaching procedures on pronunciation.

Given the recentness, degree of inconsistency and contrasting results in the investigations of both the internal-linguistic variables of markedness and phonological environment, and the external-cognitive variable of speech perception and its relationship to production in structuring IL phonology, each research question addressed in the present study seems to have potential for triggering independent and sophisticated research projects per se.

The importance of investigating the relationship between L2 speech perception

and production in instructional settings stems from in the fact that most L2 acquisition processes occur in these situations, where input and feedback from native speakers is not very frequent. Such research is essential for the development of instructional programs that are more effective for the new learners of this century. In addition, it may contribute to the discussion of the interdependency of the two skills in a broad sense, and, thus, help to unveil the intricacies of speech processing, one of the most complex challenges in the literature on human cognition.

The present study aimed at contributing to the field by providing data about a phonological and phonetic error – vowel epenthesis after word final consonants, which is one of the characteristic features of BP accent in English. By investigating a group of adult learners with a low level of proficiency in the L2, it was expected that the study could serve as reference for future investigations focusing on L2 development. The results did not show statistically significant effects of the linguistic variables examined – universal markedness relations and phonological environment, although tendencies could be identified, especially when they were compared to those obtained in Baptista and Silva Filho (1997), the study on which the present one was based. These tendencies need to be investigated more closely, and very interesting results will probably result from investigations controlling the stimuli to focus on them.

Besides these tendencies, the study showed a statistically significant relationship between L2 speech perception of the difference between sequences ##CVC## and ##CVCV##, where the last vowel is /i/, and production of word-final epenthesis at the time the learners' performance was investigated. Both showed very weak performance, an outcome that was taken as indicating these learners' lack of an appropriate representation for the difference in English, as a consequence of reliance on L1 speech signal patterns – more specifically, on the BP canonical syllabic pattern – CV.

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APPENDICES

Questionnaire Results14

PARTICIPANTS' PROFILE

'IN'	AGE	SEX	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16	Q 17	Q 18	Q 19	Q 20	Q 21	Q 22	Q 23	Q 24	Q 25	Q 26	Q 27	Q 28	Q 29	Q 30	Q 31	Q 32	Q 33	Q 34
1	22	F	Y	5	11	W	Y	Yaz	4m	99	3	B	B	6	1	N	-	-	-	-	N	N	N	Y	Y	N	N	-	-	Fp	Fp
2	19	M	Y	5	13	W	Y	CCE	3m	98	3	B	B	6	1	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
5	19	F	Y	5	11	W	Y	CNA	4m	00	3	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Tub	SC
7	18	F	Y	8	14	W	Y	Wiz	6m	99	2	UFSC	B	10	-	N	-	-	-	-	N	N	N	N	N	N	N	-	-	Bl	SC
11	23	F	Y	5	12	W	Y	Extr	8m	99	3	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
12	18	F	Y	7	12	W/O	Y	Oxon	8m	00	1	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	3B	SC
16	23	F	Y	5	11	W	Y	Udes	8m	99	2	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
18	18	F	Y	8	14	W	Y	Yaz	8m	00	3	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
19	21	F	Y	8	15	W	Y	Extr	4m	00	3	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
24	17	F	Y	5	11	W/O	Y	Yaz	8m	99	3	UFSC	B	10	-	N	-	-	-	-	N	N	N	Y	N	Y	N	-	-	SP	SP
25	18	M	Y	5	11	W	Y	CCA	8m	92	3	UNI	B	6	-	N	-	-	-	-	N	N	N	N	N	N	N	-	-	Fp	Fp
26	21	F	Y	7	13	W	Y	Wiz	8m	99	2	UNI	B	6	-	N	-	-	-	-	Y	N	N	Y	Y	Y	N	-	-	SP	SP
27	18	F	Y	5	12	W	Y	Yaz	4m	88	3	UNI	B	6	-	N	-	-	-	-	N	N	N	Y	Y	Y	N	-	-	Fp	Fp
30	19	M	Y	5	12	W/O	Y	Yaz	12m	95	3	UNI	B	6	-	N	-	-	-	-	N	N	N	Y	Y	Y	N	-	-	Fp	Fp
38	18	F	Y	5	11	W	Y	Extr	3m	95	3	UNI	B	6	-	N	-	-	-	-	N	N	N	N	N	N	N	-	-	SP	SP

14 See Key to Questionnaire Results after table

42	20	M	Y	8	15	W	Y	Sen	12m	97	3	UNI	B	6	-	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp
44	20	M	Y	5	12	W	Y	Yaz	4m	99	3	UNI	B	6	3	N	-	-	-	-	N	N	Y	Y	N	N	N	-	-	Fp	Fp
45	21	M	Y	5	11	W/O	Y	CCE	12m	98	3	UNI	B	6	-	N	-	-	-	-	N	N	Y	Y	Y	Y	N	-	-	RJ	RJ
46	17	M	Y	6	12	W	Y	Fisk	8m	97	3	UNI	B	6	-	N	-	-	-	-	N	N	Y	Y	Y	N	N	-	-	Ca	PA
47	18	F	Y	5	12	W/O	Y	Ins E	8m	99	3	B	B	6	2	N	-	-	-	-	N	N	N	Y	N	N	N	-	-	Fp	Fp

Key

Q 7
5 – 5ª série
6 – 6ª série
7 – 7ª série
8 – 8ª série

Q9
W – writing & reading
O – oral

Q 15
B – *Fundação Barddal de Educação e Cultura*
UNI – *Unidade Catarinense de Ensino Superior*
UFSC – *Universidade Federal de Santa Catarina*

Q 16
B – Basic Level

Q 33
Fp Florianópolis
Ca Caxias do Sul
Bl Blumenau
Tub Tubarão
3B Três Barras
Itaj Itajaí
RJ Rio de Janeiro
SP São Paulo

Q 34
Fp Florianópolis
SC Santa Catarina
PA Paraná
SP São Paulo

Appendix B

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Aluna: Profª Rosana Denise Koerich
Orientadora: Profª Drª Barbara Oughton Baptista

IN: _____

QUESTIONÁRIO SOBRE PARTICIPANTES DE PESQUISA DE CAMPO

Por favor, responda às perguntas abaixo. Este questionário visa somente obter informações que serão utilizadas para direcionar a análise dos dados da pesquisa conduzida pela aluna acima citada. Em nenhuma hipótese os nomes dos participantes serão divulgados, pois se trata de uma pesquisa quantitativa. Solicito informar nome e telefone somente para, no caso de necessitar alguma informação adicional, poder entrar em contato com você posteriormente.

1. NOME: _____ 2. DATA: _____

3. IDADE: _____ 4. SEXO: FEM / MASC 5. TEL: _____

Responda às perguntas abaixo tendo em mente que o objetivo é traçar um perfil de seu contato com o inglês. Tente ser o mais específico/a possível. Faça qualquer tipo de comentário que julgar interessante para dar uma visão fiel deste contato.

6. Fez inglês no colégio? SIM / NÃO

7. Desde que série? _____

8. Qual sua idade na época? _____

9. As aulas exploravam comunicação escrita e oral?

_____

_____

10. Fez curso de inglês? SIM / NÃO

11. Qual curso/escola?

_____

12. Em que ano começou? _____

13. Em que ano terminou/parou? _____

14. Quantas horas por semana tinha o curso em média? _____

15. Qual o curso de inglês que freqüenta no momento?

IN:

16. Qual nível/semestre/fase que freqüenta no momento? _____

17. Quantas horas semanais tem este curso? _____

18. Quantas horas por semana, além do curso, você dedica ao estudo da língua inglesa / a atividades para aperfeiçoar seu inglês?

_____

19. Tem vivência em país de língua inglesa? (mais de 1 mês) SIM / NÃO

20. Por quanto tempo? _____ 21. Qual sua idade na época? _____

22. Freqüentou escola naquele país? SIM / NÃO

23. Que tipo de escola/ curso?

_____

24. Conversa com freqüência em inglês com outros brasileiros? SIM / NÃO

25. Conversa com freqüência em inglês com falantes nativos? SIM / NÃO

26. Assiste filmes sem dublagem com freqüência? SIM / NÃO

27. Ouve música em inglês com freqüência? SIM / NÃO 28. Canta? SIM / NÃO

29. Transcreve (tira) letras de músicas? SIM / NÃO

30. Estuda, estudou, ou tem contato com outra língua estrangeira? SIM / NÃO

31. Em que contexto? (escola, na família...) _____

32. Qual língua? _____

33. Em que cidade foi criado/a? _____

34. Qual seu sotaque no português? (por exemplo: norte/ nordeste/sul do país, do estado)

_____

35. Acrescente qualquer informação que julgar interessante

_____

_____

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Researcher: Profª Rosana Denise Koerich
Adviser: Profª Drª Barbara Oughton Baptista

IN: _____

QUESTIONNAIRE ABOUT RESEARCH PARTICIPANTS

Please answer the questions below.
This questionnaire aims only at gathering information that will help in the analysis of the research data. Under no circumstances will the names of the participants be revealed, as this research is strictly quantitative. I request your name and phone number only for the purpose of contacting you later in case more information is needed.

1. NAME: _____ 2. DATE: _____

3. AGE: _____ 4. SEX: FEM / MASC 5. PHONE: _____

Please, answer the questions below, bearing in mind that they will help to characterize your contact with English. Be as specific as possible. Add any comment that may be important to give a complete and accurate view of this contact.

6. Did you study English in high school? YES / NO

7. When did you start? _____

8. How old were you at the time? _____

9. Did the classes develop both written and oral expression?

_____

_____

10. Have you taken a language course? YES / NO

11. What course?

_____

12. When did you start? _____

13. When did you finish/stop? _____

14. How many class a week, on the average were devoted to the course? _____

15. What English course are you presently taking?

_____

IN:

16. What level ? _____

17. How many class hours a week are devoted to the course? _____

18. How many hours a week, besides the course hours, do you dedicate to the study of English/to activities to improve your English?

_____

19. Have you lived in an English speaking country? (longer than 1 m) YES / NO

20. For how long? _____ 21. How old were you at the time? _____

22. Did you go to school there? YES / NO

23. What kind of school/ course was it?

_____

24. Do you often speak English with other Brazilians? YES / NO

25. Do you often speak English with native speakers? YES / NO

26. Do you often watch films without dubbing? YES / NO

27. Do you often listen to music in English? YES / NO

28. Do you sing? YES / NO

29. Do you try to write the lyrics to the songs you hear? YES / NO

30. Do you study/have you studied/do you have contact with any other FL? YES / NO

31. In what context? (school, family...) _____

32. What language? _____

33. Where did you grow up? _____

34. What is your regional accent? (in Portuguese)

_____

35. Add any information about your contact with English you consider important.

_____

_____

Appendix C

SENTENCE READING TEST

/p/		
p	THE CHEAP PENS ARE HERE.	1
b	THE TOP BED IS MARY'S.	2
t	I'LL TRY A PEP TALK.	3
d	SHE DOES TAP DANCE.	4
k	THE BEEP CAN BE HEARD.	5
g	THE TROOP GOES QUICKLY.	6
tʃ	ONION SOUP CHEERS HER UP.	7
dʒ	THEY KEEP JAM IN THE FRIDGE.	8
f	THE COP FELL DOWN OVER THERE.	9
v	I SAW PAUL ON THE TROOP VAN.	10
θ	THEY SELL CHEAP THINGS THERE.	11
ð	THEY FLAP THEIR WINGS FURIOUSLY.	12
s	HE'LL BE ON THE TOP SOON.	13
ʃ	THE TIP SHOULD BE GIVEN TO HER.	14
h	THE MAP HAS BEEN STUDIED.	15
m	THEY OFFER CHEAP MEALS.	16
n	THE CUP NEEDS TO BE WASHED.	17
l	THE SHIP LOOKS OLD.	18
r	THIS COP RUNS FAST.	19
w	THE BOY'S CUP WAS EMPTY.	20
æ	SHE HAS TO KEEP ADS HERE .	21
ʌ	SHE HAS TO KEEP UP WITH ME.	22

	oʊ	IT'S ON THE TOP OAK SHELF.	23
	∅	THE BABY FELL FROM MY LAP.	24
/b/			
	p	BOB PAYS HER BILLS.	25
	b	THE LAB BOOK IS ON THE COUNTER.	26
	t	THE MOB TOOK DOWN THE SIGN.	27
	d	THERE'S A PUB DOWN THERE.	28
	k	ROB CARPS ALL THE TIME.	29
	g	THE TUB GOT FULL.	30
	tʃ	ROB CHEERS FOR THE LAKERS.	31
	dʒ	BOB JOINS THEM IN THE PARK.	32
	f	I GO TO THE PUB FOR A DRINK.	33
	v	I SAW THE CAB VEER.	34
	θ	BOB THINKS SHE IS AWAY.	35
	ð	SHE SAW THE TUB THERE.	36
	s	MY PEN'S NIB SEEMS TO BE BROKEN.	37
	ʃ	THE LAB SHOULD BE OPENED.	38
	h	THE CRAB HURT HIS FINGER.	39
	m	THEY DUB MY FAVORITE ACTORS.	40
	n	ROB NEEDS A NEW CAR.	41
	l	THE PUB LIGHTS ARE ON.	42
	r	HE GOES THERE TO ROB RICH PEOPLE.	43
	w	THE CRIB WAS NEW.	44
	æ	THE PUB ADS ARE FUNNY.	45
	ɑ	THEY SAW TOB ON MONDAY.	46

ɔ	THEY GAB ALL THE TIME.	47
∅	I SAW THEIR LAB.	48

/t/

p	THE WET PAD WAS ON THE SOFA.	49
b	SHE HAS TO GET BACK TO WORK.	50
t	THIS IS THE HOT TAP.	51
d	SHE BUYS A HOT DOG FOR HIM.	52
k	I SAW THEM PUT CUFFS ON HIM.	53
g	THE WET GUYS RAN TO THE HOUSE.	54
tʃ	THEY PUT CHAIRS ON THE GRASS.	55
dʒ	THEY LET JOHN GO.	56
f	THE MEAT FELL ON THE FLOOR.	57
v	THEY PUT VEILS ON.	58
θ	THE VET THOUGHT THEY'RE DEAD.	59
ð	SHE SET THEM ON THE SHELF.	60
s	PAT SAW HER BOYFRIEND THERE.	61
ʃ	THEY WILL LET SHIPS COME INSHORE.	62
h	MY BOOT HEEL WAS BROKEN.	63
m	THE CAT MEANS A LOT TO HER.	64
n	THIS MAT NEEDS WASHING.	65
l	I TAUGHT LIT IN HIGH SCHOOL.	66
r	THIS PET RUNS QUICKLY.	67
w	THEIR CAT WAS OVER THERE.	68
ɛ	THERE WAS A BAT EGG.	69

ʌ	THEY PUT UP NEW BUILDINGS.	70
oʊ	HE IS A BIT OLD FOR ME.	71
∅	I WILL BUY THIS FLAT.	72

/d/

p	THIS IS THE BAD PEAR.	73
b	THE PAPER'S IN THE DEED BOX.	74
t	SHE WAS ON A GOOD TEAM.	75
d	HE'S BEEN A GOOD DEAN.	76
k	SHE WAS IN GOOD CARE.	77
g	SHE'S CHEWING RED GUM.	78
tʃ	TED CHEERS FOR THE LAKERS.	79
dʒ	SHE HAS A GOOD JOB.	80
f	THE FOOD FAD HAS CHANGED.	81
v	THIS MAY BE A BROAD VIEW.	82
θ	HE WAS A SAD THIN BOY.	83
ð	I'LL ADD THE OTHER INGREDIENTS.	84
s	THE BLOOD SOON DRIED ON HIS SKIN.	85
ʃ	WE SAW A VERY BAD SHOW.	86
h	MY DAD HAS BEEN TRAVELING.	87
m	HE IS THE HEAD MAN THERE.	88
n	THE FOOD NEEDS TO BE REPLACED.	89
l	THIS KID LIES TO ME OFTEN.	90
r	THE KID RAN TO THE DOOR.	91
w	THE COD WAS DELICIOUS.	92

oʊ	HE WAS A SAD OLD MAN.	93
ɑ	THERE WAS A PAD ON THE TABLE.	94
ɛ	THEY BREED ELMS HERE.	95
∅	THE ARTICLE WAS A DUD.	96

/k/

p	HE TOOK PAM TO THE FARM.	97
b	WE SAW THE BLACK BEAR.	98
t	RICK TAUGHT HIM TO READ.	99
d	THE SICK DEAN GAVE A SPEECH.	100
k	YOUR CHECK CAN BE CASHED HERE.	101
g	THEY WILL LOOK GAUNT.	102
tʃ	THE BLACK CHAIRS ARE CHEAPER.	103
dʒ	HE WEARS BLACK JEANS ONLY.	104
f	THERE IS A BOOK FAIR HERE.	105
v	THE TRUCK VEERS SUDDENLY.	106
θ	HE WAS A WEAK THIN GUY.	107
ð	THE THUNDER SHOOK THEM.	108
s	THIS PACK SEEMS MOLDY.	109
ʃ	THEY'LL GO TO A TRUCK SHOW.	110
h	JACK HAS TO GO NOW.	111
m	HE WAS A WEAK MAN.	112
n	I SAW A RACK NEAR THE CAR.	113
l	THERE WAS A BLACK LASH HERE.	114
r	THERE WAS A BANK RAID TODAY.	115

w	SHE HAS A THICK WAIST.	116
ɛ	THE SICK ELM WAS DYING.	117
ɑ	THERE'S A PACK ON THE TABLE.	118
oʊ	NICK OWES ME FIFTY DOLLARS.	119
∅	THE TRAIN IS ON THE TRACK.	120

/g/

p	MEG PAYS ALL HIS BILLS.	121
b	THE BIG BANK WAS CLOSED.	122
t	THE DOG TAIL WAS BROKEN.	123
d	MY SISTER HAS A RAG DOLL.	124
k	THIS PEG CAN BE DANGEROUS.	125
g	THE RUG GETS DIRTY EASILY.	126
tʃ	GREG CHEERS HER UP.	127
dʒ	THE FROG JUMPS HIGH.	128
f	THERE IS A BIG FAIR AT SCHOOL.	129
v	HIS PROBLEM IS IN A LEG VEIN.	130
θ	THE THUG THOUGHT HE WAS FREE.	131
ð	I CAN SEE THE FIG THERE.	132
s	I WILL DIG SEEDS THERE.	133
ʃ	THE BIG SHOE IS BLUE.	134
h	MY LEG HURTS EVERY DAY.	135
m	YOUR BAG MAY HAVE BEEN STOLEN.	136
n	MEG NAGS HIM OFTEN.	137
l	THIS WIG LOOKS TERRIBLE.	138

r	THE HOG RAN TO THE WATER.	139
w	THE LOG WAS HERE YESTERDAY.	140
ɑ	YOU MAY LOG OFF NOW.	141
æ/ə	I WILL SEE THE MAG ADDS.	142
oʊ	HE IS A BIG OAF.	143
∅	THIS IS THE ITALIAN FLAG.	144

/f/

p	JEFF PAYS THE RENT.	145
b	THE THIEF BET WE WERE OUT.	146
t	CLIFF TAUGHT FRENCH IN HIGH SCHOOL.	147
d	I WILL BUFF DON'S SHOES.	148
k	THE DEAF COP WAS DISMISSED.	149
g	I SAW CLIFF GO AWAY.	150
tʃ	THE DEAF CHILD WAS IN THE CLASS.	151
dʒ	THE PROOF JUST BECAME CLEAR.	152
f	THE LEAF FELL FROM THE TREE.	153
v	I SAW THE CHIEF VEER SHARPLY.	154
θ	HE WILL BUFF THINGS FOR ME.	155
ð	SHE WILL FLUFF THE PILLOWS.	156
s	BIFF SAILS ON THE WEEKENDS.	157
ʃ	THE CHIEF SHALL BE HERE SOON.	158
h	THE CHEF HAS FUNNY IDEAS.	159
m	WE SAW THE DEAF MAN.	160
n	WE BUFF NAILS HERE.	161

l	HE WEARS GOLDEN CUFF LINKS.	162
r	THE THIEF RAN TO THE MALL.	163
w	THE BEEF WAS EATEN.	164
æ	WE SAW THE REEF AT NOON.	165
oʊ	CLIFF OWES ME AN EXCUSE.	166
ɑ	THERE WAS A LEAF ON THE FLOOR.	167
∅	THEY FLEW OVER THE CLIFF.	168

/v/

p	I GAVE PAM YOUR NUMBER.	169
b	THERE ARE FIVE BEDS HERE.	170
t	THEY LOVE TO TRAVEL.	171
d	HE DROVE DOWN TO THE STORE.	172
k	I WILL GIVE KIM A PEN.	173
g	THE BRAVE GUY SURVIVED.	174
tʃ	THEY HAVE CHEAP CARS HERE.	175
dʒ	I WILL LEAVE JUST THE NEW ONES.	176
f	THE DOVE FLEW TO THE SOUTH.	177
v	WE DRIVE VANS AND LIMOS.	178
θ	I'LL HAVE THICK STEAKS.	179
ð	I'LL MOVE THE TABLE.	180
s	YOU ARE A BRAVE SOUL.	181
ʃ	I CAN PROVE SHE WAS HERE.	182
h	HE GAVE HER A NICE GIFT.	183
m	SHE GAVE ME A FORM.	184

	THEY TOSS THINGS INTO THE AIR.	214
ð	THERE IS NO CHOICE THEN.	215
	THERE IS LESS THAN YOU SAID.	216
s	I SAW THE LACE SENT TO ANN.	217
	MY BOSS SANG AT THE PARTY.	218
ʃ	THIS IS A NICE SHIRT.	219
	WE'LL GO TO A BASS SHOW.	220
h	HE THREW THE DICE HIGH.	221
	HE WAS IN THE MESS HALL.	222
m	THE PROGRAM HAS VOICE MAIL.	223
	I FLOSS MY TEETH EVERY DAY.	224
n	YOUR NIECE NEEDS TO STUDY HARDER.	225
	I WILL MISS NEIL.	226
l	THE RACE LASTS FOUR HOURS.	227
	SHE WILL KISS LEO.	228
r	THE MICE RAN TO THE HOLE.	229
	HE WILL MISS RUTH.	230
w	NO TRACE WAS FOUND HERE.	231
	THE GROSS WEIGHT IS 3 KILOS.	232
ɛ	THE RACE ENDS IN ONE HOUR.	233
	THE MASS ENDS IN TEN MINUTES.	234
ɑ	THERE IS RICE ON THE FLOOR.	235
	I SAW YOUR GLASS ON THE TABLE.	236
oʊ	GRACE OWES ME AN EXCUSE.	237
	MY BOSS OWES ME 40 DOLLARS.	238
∅	HE WILL THROW THE DICE.	239
	SHE PLAYS THE DOUBLE BASS.	240

/z/

p	THEY FREEZE PEAS.	241
	LIZ PEELS THE POTATOES FOR US.	242
b	HE OWNS A PRIZE BULL.	243
	HE PLAYS IN A JAZZ BAND.	244

t	YOU WILL FREEZE TO DEATH.	245
	THERE WAS A QUIZ TO REVISE GRAMMAR.	246
d	THIS MAZE DRIVES ME CRAZY.	247
	HE HAS MANY JAZZ DISCS.	248
k	FEEL THE BREEZE COOL YOUR FACE.	249
	HIS FUZZ KILLS ME.	250
g	THE HAZE GOT WORSE.	251
	THE BUZZ GOT WORST.	252
tʃ	THIS BREEZE CHEERS ME UP.	253
	YOUR JAZZ CHEERS ME UP.	254
dʒ	THE CRAZE JUST STARTED.	255
	THE BUZZ JUST STARTED.	256
f	IT WILL BLAZE FOR DAYS.	257
	I HEAR THE BUZZ FAR AWAY.	258
v	THEY FREEZE VEAL.	259
	I HEAR THEM FIZZ VIA THE PHONES.	260
θ	THEY FROZE THICK SLICES OF CAKE.	261
	LIZ THOUGHT I WAS JOKING.	262
ð	SHE'LL SEIZE THE OPPORTUNITY.	263
	HE GREW A FUZZ THIS MONTH.	264
s	YOU WILL SEE THE PRIZE SOON.	265
	HE HAS A JAZZ SOUL.	266
ʃ	THEY GRAZE SHEEP THERE.	267
	HE WAS ON A QUIZ SHOW.	268
h	THE GLAZE HAS FINE CRACKS.	269
	THIS BUZZ HAS MADE ME CRAZY.	270
m	SHE FROZE ME OUT.	271
	THE FIZZ MIGHT ESCAPE.	272
n	THERE'S A BREEZE NOW.	273
	THE BAR HAS A QUIZ NIGHT.	274
l	THIS WAS A CRAZE LAST YEAR.	275
	THE BUZZ LASTS FOR HOURS.	276
r	I SAW THE MAZE RATS.	277

	LIZ RAN TO THE FRONT DOOR.	278
w	THE HAZE WAS VERY DENSE.	279
	THE QUIZ WAS ON HISTORY.	280
æ	THEY GAZE AT THE PAINTING.	281
	SHE SAW THE JAZZ AD.	282
ʌ	I'LL SIZE UP THE SITUATION.	283
	I SAW THEM FIZZ UP IN THE SKY.	284
ɔ	WE GAZE ALL DAY LONG.	285
	SHE HEARS A BUZZ ALL DAY LONG.	286
∅	SHE IS A SMALLER SIZE.	287
	I HEAR A BUZZ.	288

/ʃ/

p	I WILL BRUSH PAST THEM.	289
b	THERE IS A TRASH BAG HERE.	290
t	THEY WILL DASH TO THE HOSPITAL.	291
d	I'LL GO TO THE CASH DESK.	292
k	SHE HAS HER CASH CARD.	293
g	THE RASH GETS WORSE IN THE SUMMER.	294
tʃ	I WISH CHUCK WAS HERE TODAY.	295
dʒ	SHE HAS A CRASH JOB.	296
f	SHE SELLS FRESH FISH HERE.	297
v	THEY WILL TRASH VIN'S CAR.	298
θ	THEY CAN PUSH THINGS AHEAD.	299
ð	HE WILL BASH THE SECRETARIES.	300
s	JOSH SAW YOU AT THE PARTY.	301
ʃ	I WISH SHE WERE HERE.	302
h	SHE TRIES TO PUSH HER IDEAS FORWARD.	303

m	I BRUSH MY TEETH EVERY HOUR.	304
n	I WILL WEAR MY POSH NEW DRESS.	305
l	THE DISH LOOKS TERRIBLE.	306
r	THERE IS A DISH RACK HERE.	307
w	THEY WILL CLASH WITH THE POLICE.	308
æ	THERE IS FRESH AIR HERE.	309
ɔ	I DIDN'T CRUSH ALL THE EGGS.	310
ʌ	WE CASH UP EVERYDAY.	311
∅	SHE IS A REAL DISH.	312

/tʃ/

p	SHE IS NOW ON MATCH POINT.	313
b	HE IS A BEACH BOY.	314
t	THIS IS A CRUTCH TO MEMORY.	315
d	SHE IS A RICH DOLL.	316
k	MITCH CAN GO WITH YOU.	317
g	I MAY TEACH GAIL.	318
tʃ	EACH CHILD WAS INTRODUCED.	319
dʒ	HE IS A RICH JERK.	320
f	THERE WAS A BEECH FLOOR.	321
v	SHE WILL SEE EACH VIEW.	322
θ	I'LL FETCH THINGS TOMORROW.	323
ð	I'LL RUN TO CATCH THE POST.	324
s	I WILL WATCH SAM WORKING.	325
ʃ	THIS CLUTCH SHALL BE FIXED.	326
h	YOU WILL CATCH HIS EYE.	327

m	ALL THE RICH MEN WERE THERE.	328
n	THE BEACH NEEDS TO BE CLEANED.	329
l	THE DUTCH LAW IS FAIR.	330
r	THE BEACH ROADS WERE FULL.	331
w	HE HAS A MATCH WITH SAMPRAS.	332
æ	I'LL SEE THE MATCH ADDS.	333
ʌ	I'LL NEVER CATCH UP WITH HER.	334
oʊ	THEY MATCH OLD WITH NEW.	335
∅	THERE WAS A TECHNICAL HITCH.	336

/dʒ/

p	HIS PLEDGE PUT HIM IN DEBT.	337
b	I RAN TO THE EDGE BY MYSELF.	338
t	THERE WAS A NEW EDGE TO HIS VOICE.	339
d	HIS GRUDGE DOES HIM BAD.	340
k	THE LODGE CAN BE RENTED.	341
g	HER RAGE GOT WORSE.	342
tʃ	THEY OWN A HUGE CHAIN OF HOTELS.	343
dʒ	THE WAGE JUST INCREASED.	344
f	SHE HAS A LODGE FOR THE NIGHT.	345
v	HE'LL NUDGE VAL.	346
θ	THE SAGE THOUGHT FOR A WHILE.	347
ð	THEY WILL DREDGE THE WHOLE RIVER.	348
s	THE FUDGE SEEMS DELICIOUS.	349
ʃ	THE BADGE SHALL BE GIVEN TO LISA.	350

h	THE JUDGE HAS MANY BOOKS.	351
m	THE JUDGE MUST BE HERE.	352
n	SHE IS A SAGE NUN.	353
l	THE JUDGE LED HIM TO COURT.	354
r	THE FRIDGE RACK IS BROKEN.	355
w	MY LODGE WAS WONDERFUL.	356
oʊ	THEY BRIDGE OLD AND NEW POLICIES.	357
ɛ	THIS PAGE ENDS HERE.	358
ʌ	HE'S ON THE RIDGE UP THERE.	359
∅	WE SAW HIM ON THE LEDGE.	360

/m/

p	WE'LL GO THROUGH THE SAME PATH.	361
	TOM PLAYS SOCCER.	362
b	THERE WAS A TIME BOMB HERE.	363
	I SAW PAM BAKE A CAKE.	364
t	SHE IS TOO LAME TO WALK HERE.	365
	THEY CLAIM TO BE INNOCENT.	366
d	I SAW HER ON THE SAME DAY.	367
	TIM DUG A HOLE OVER THERE.	368
k	THE CRIME CAN BE SOLVED.	369
	THE DRUM CAN BE SOLD HERE.	370
g	TIME GOES ON.	371
	TIM GOES THERE ON SUNDAYS.	372
tʃ	THEY'RE IN THE SAME CHURCH.	373
	THEY PLAY THE TEAM CHANT.	374
dʒ	THE FLAME JUST SPREAD AROUND.	375
	KIM JOINS US IN THE PARK.	376
f	THEY WILL COME FOR THE PARTY.	377
	THEY PLAY DOOM FOR HOURS.	378

v	SHE HAS THE SAME VIEW I DO.	379
	YOU WILL SEEM VAIN.	380
θ	I SAW THE SAME THING THERE.	381
	JIM THINKS HE IS ALWAYS RIGHT.	382
ð	THERE IS A FRAME THERE.	383
	THEY CLAIM THAT YOU SAW THEM.	384
s	THEY ARE IN THE SAME CELL.	385
	THERE IS CLAM SOUP FOR DINNER.	386
ʃ	THEY ARE ON THE SAME SHIP.	387
	MOM SHOT THE GUY.	388
h	I'LL FRAME HER PICTURE.	389
	SHE THREW THE GEM HIGH.	390
m	YOUR TIME MAY BE SHORT.	391
	I'LL TRIM MY HAIR.	392
n	THERE IS NO HOME NEWS.	393
	MOM NEEDS TO WORK.	394
l	SHE CAME LAST SATURDAY.	395
	TIM LOOKS TIRED.	396
r	HE PLAYS THE SAME ROCK SONGS.	397
	TOM RAN AWAY FROM ME.	398
w	HIS RHYME WAS HORRIBLE.	399
	THE CLAM WAS SOLD.	400
ɑ /ɔ	THERE WAS A CRIME ON THE PLANE.	401
	TRIM OFF THE LEAFY ENDS.	402
ɛ	THE GAME ENDS IN TEN MINUTES.	403
	HERE IS WHERE YOUR DREAM ENDS.	404
oʊ	THEY PLAY THE SAME OLD SONGS.	405
	THEY SEEM OLD TO ME.	406
∅	SHE WAS HOME.	407
	I CAN HEAR A DRUM.	408

/n/

p	JANE PLAYS VOLLEYBALL.	409
	BEN PLAYS TENNIS.	410
b	I CAN SEE NINE BOATS.	411
	I CAN SEE TEN BOATS.	412
t	ONLY JANE TELLS THE TRUTH.	413
	ONLY DAN TELLS THE TRUTH.	414
d	THE LINE DIES HERE.	415
	THE MAN DUG A HOLE HERE.	416
k	THE TONE COULD BE HEARD.	417
	THE LOAN CAN BE SENT TO YOU.	418
g	JANE GOES TO WORK EVERYDAY.	419
	KEN GOES TO LONDON EVERY YEAR.	420
tʃ	SHE HAS A FINE CHIN.	421
	SHE WAS A MEAN CHILD.	422
dʒ	MY CANE JUST BROKE.	423
	THE TRAIN JUST ARRIVED.	424
f	HE HAS NINE FARMS.	425
	THE TEAM WON FOUR ROUNDS.	426
v	HE OWNS NINE VANS.	427
	THE MAIN VERB IS IN THE PAST.	428
θ	THIS IS A FINE THING YOU DO.	429
	THERE'RE TEN THICK VOLUMES HERE.	430
ð	SHE HAS DONE THEM GOOD.	431
	SHE HAS SEEN THEM FREQUENTLY.	432
s	THE PLANE SOON LANDED.	433
	THE SUN SOON DISAPPEARED.	434
ʃ	SHE WEARS ONLY FINE SHOES.	435
	TWO MEN SHOT THE OFFICER.	436
h	SHE HAS VERY FINE HAIR.	437
	THE SUN HIT MY EYE.	438
m	THIS BONE MUST BE BROKEN.	439
	THE RAIN MUST COME TO AN END.	440
n	THE LANE NEEDS SOME REPAIR.	441

	THE NUN NEEDS THEM.	442
l	HER PLANE LANDS IN 3 MINUTES.	443
	DAN LOOKS TIRED.	444
r	JANE RAN SIX MILES.	445
	BEN RUNS FASTER THAN TOM.	446
w	THE CRANE WAS BROKEN.	447
	THE SUN WAS INTENSE.	448
ɑ	SHE HAS TO DINE ON HER OWN.	449
	I SAW THE CLAN ON MY WAY HOME.	450
ɛ	THE HENS LAY NINE EGGS A WEEK.	451
	THERE WERE TEN EGGS IN THE FRIDGE.	452
oʊ	THEY SELL FINE OATS HERE.	453
	THE CLAN OWNS HALF OF THE CITY.	454
∅	THERE IS AN ENORMOUS DUNE.	455
	SHE ALWAYS HAS FUN.	456

Appendix D

SENTENCE READING TEST

Instructions

Este envelope contém o seguinte material para o teste:

2 blocos para leitura
1 folha cartão

1. Escreva seu nome legível no envelope.
2. Retire a fita do aparelho, escreva seu nome na etiqueta e devolva afita ao aparelho (ATENÇÃO PARA A POSIÇÃO DE ROLAGEM)
3. Não pressione nenhuma tecla.
4. Retire do envelope a folha cartão e o bloco preso com clips VERDE.
5. Deixe o bloco virado para baixo a sua frente.
6. Coloque o envelope no chão.
7. Você vai gravar sua leitura das sentenças contidas no bloco com clips VERDE de acordo com os seguintes passos:

- RETIRE O CLIPS DO BLOCO
- CUBRA AS SENTENÇAS COM O CARTÃO E VÁ CORRENDO O MESMO A MEDIDA QUE FOR LENDO CADA SENTENÇA
- LEIA CADA SENTENÇA UMA VEZ.
- HÁ PALAVRAS DESCONHECIDAS, NÃO É ESPERADA PERFEIÇÃO, LEIA COMO ACHAR QUE DEVE SER.

8. Após colocar o fone confortavelmente, ao comando da pesquisadora, pressione a tecla <DRILL> e proceda a gravação da sua leitura das sentenças.
9. Ao terminar sua leitura, pressione <STOP> e

COM O MÍNIMO BARULHO POSSÍVEL

10. Recoloque o clips no bloco que acabou de ler (não precisa organizar, é só juntar as folhas) e devolva o bloco ao envelope.
11. Pegue o bloco de clips VERMELHO e proceda da mesma forma, com o cartão, etc.

LEMBRE DE PRESSIONAR <DRILL>.

Grata pela colaboração.

SENTENCE READING TEST

Instructions

This envelope contains the following material for the test:

2 blocks for the reading test
1 card

1. Write your name on the envelope.
2. Remove the tape from the tape recorder, write your name on the tag of the tape and insert it in the tape recorder (ATTENTION TO THE POSITION OF THE TAPE)
3. Do not press any button.
4. Remove the card and the block with the GREEN clips from the envelope.
5. Leave the block with the backside up in front of you
6. Put the envelope on the floor.
7. You are going to record your reading of the sentences in the block with the GREEN clips. Follow these steps:

- REMOVE THE CLIPS
- COVER THE SENTENCES WITH THE CARD AND CONTINUE SLIDING THE CARD DOWN AS YOU PROCEED WITH EACH SENTENCE.
- READ EACH SENTENCE ONLY ONCE. YOU MAY REPEAT THE READING OF WORDS BUT DO NOT REPEAT ANY SENTENCE.
- THERE ARE SOME UNFAMILIAR WORDS. YOU ARE NOT EXPECTED TO READ PERFECTLY. READ THE WAY YOU BELIEVE TO BE CORRECT.

8. Set the earphone comfortably and, at the command of the researcher, press <DRILL> and start your recording of the sentences.
9. When you finish the reading, press <STOP> and

AS QUIETLY AS POSSIBLE

10. Put the clips back (it's not necessary to organize the sheets; just put them together). Put the block back in the envelope.
11. Take out the block with the RED clips and proceed as you did with the previous block using the card, etc.

REMEMBER TO PRESS <DRILL>

Thank you for your cooperation.

SENTENCE READING TEST[15]

HE'LL BE ON THE TOP SOON.

THERE WAS A BAT EGG.

MR. ROSS CHOSE THESE TWO BOOKS.

THERE WAS A BEECH FLOOR.

THEY PLAY DOOM FOR HOURS.

HE PLAYS THE SAME ROCK SONGS.

THERE'S A BREEZE NOW.

THERE IS A BIG FAIR AT SCHOOL.

THEY SAW TOB ON MONDAY.

THE TOP BED IS MARY'S.

THE THIEF BET WE WERE OUT.

I'LL RACE TO THE BANK.

JOSH SAW YOU AT THE PARTY.

HIS RHYME WAS HORRIBLE.

BEN RUNS FASTER THAN TOM.

HE'LL NUDGE VAL.

I WILL BRUSH PAST THEM.

HE OWNS A PRIZE BULL.

THE COD WAS DELICIOUS.

YOUR BAG MAY HAVE BEEN STOLEN.

THE GROSS BOY WAS CRYING.

THERE'S A PACK ON THE TABLE.

THE PUB ADDS ARE FUNNY.

THIS WIG LOOKS TERRIBLE.

[15] Sample page from 'Randomized Order 1'

Appendix E

UNIVERSIDADE FEDERAL DE SANTA CATARINA
CURSO DE PÓS-GRADUAÇÃO EM LETRAS/INGLÊS E LITERATURA CORRESPONDENTE
FREE SPEECH TEST

Fale por um minuto sobre você mesmo.

Para realizar esta tarefa, pressione <<DRILL>> ao comando da pesquisadora e inicie sua gravação.
Ao terminar, pressione <<STOP>> e aguarde.

Se quiser, use o seguinte esquema para lhe auxiliar.

DIGA

- SEU NOME
- IDADE
- ESTADO CIVIL
  FALE SOBRE SUA FAMÍLIA
- PROFISSÃO
- ONDE VOCÊ NASCEU
- ONDE MORA
- ONDE ESTUDA
- COISAS QUE VOCÊ GOSTA/ NÃO GOSTA
  DE FAZER
  DE COMER
- SEUS PLANOS PARA O FUTURO

UNIVERSIDADE FEDERAL DE SANTA CATARINA
CURSO DE PÓS-GRADUAÇÃO EM LETRAS/INGLÊS E LITERATURA CORRESPONDENTE
FREE SPEECH TEST

Talk about yourself for one minute.

To perform this task, press <DRILL> at the command of the researcher and start recording.
When you hear 'stop', press the <STOP> button.

If you wish, use the following outline to help you.

SAY

- YOUR NAME
- AGE
- MARITAL STATUS
- TALK ABOUT YOUR FAMILY
- PROFESSION
- PLACE OF BIRTH
- WHERE YOU LIVE
- WHERE YOU STUDY
- THINGS YOU LIKE/DON'T LIKE DOING/ EATING
- YOUR PLANS FOR THE FUTURE

Appendix F

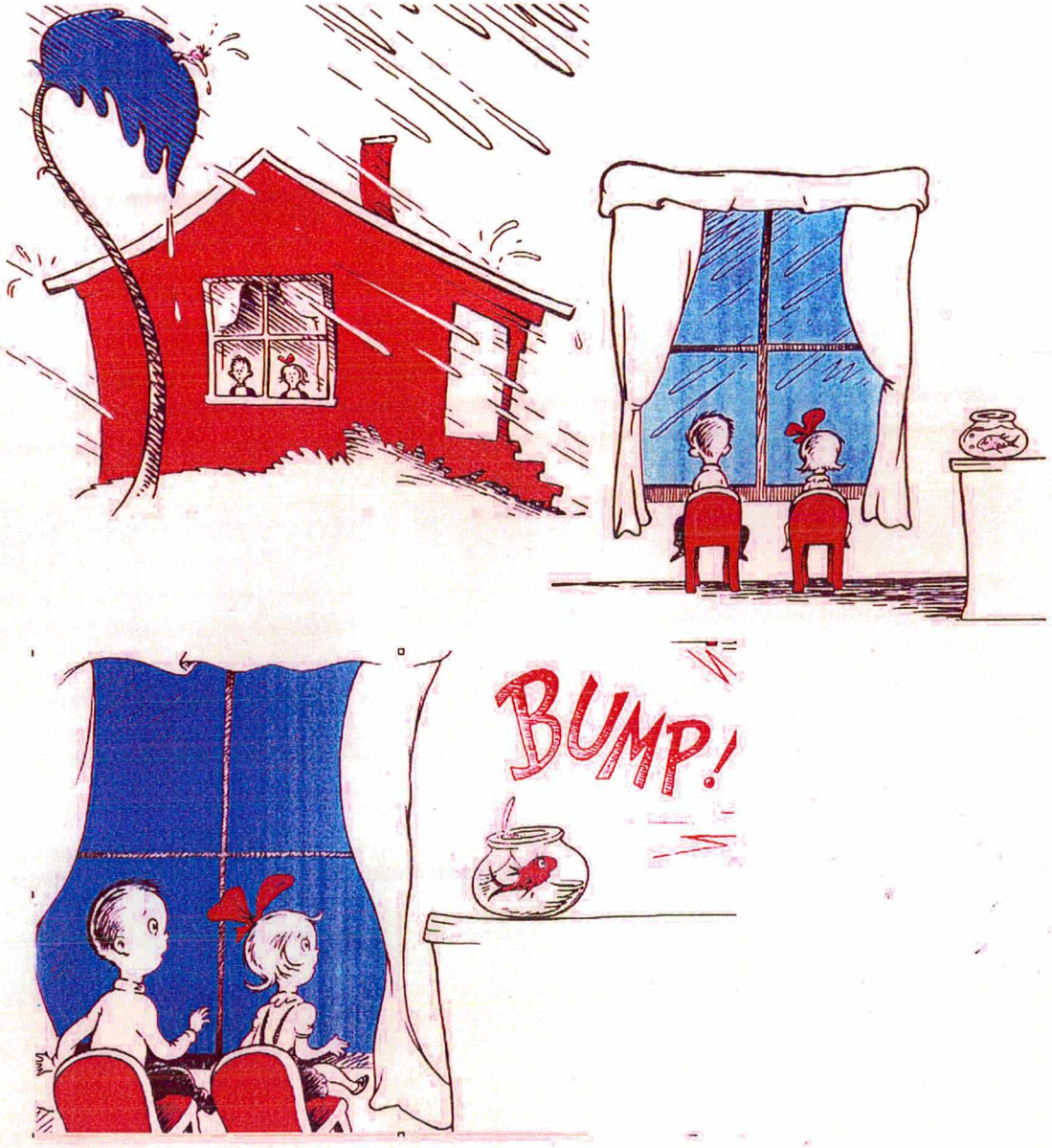
STORY RETELLING TEST

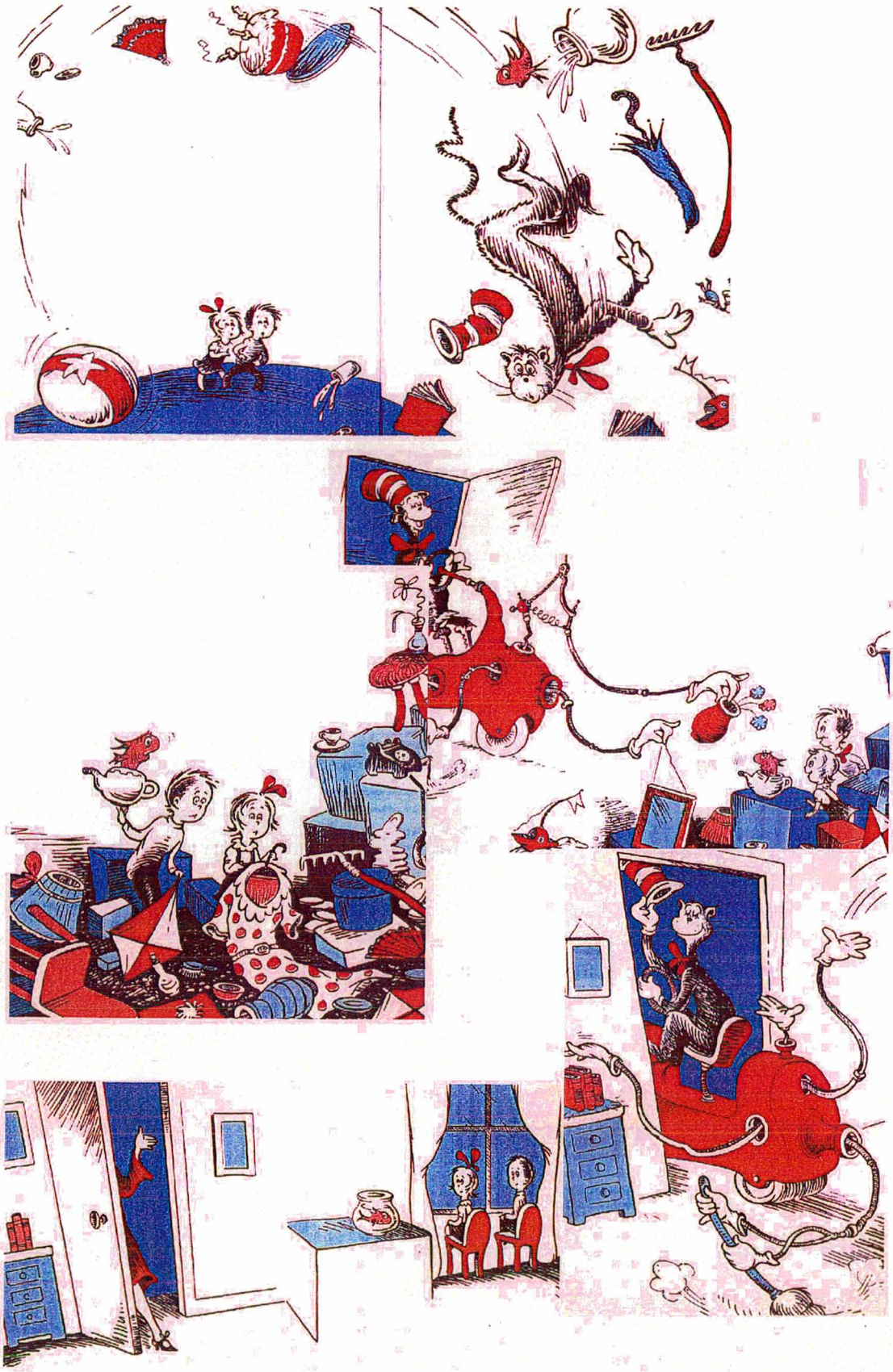
Source: Seuss, Dr. The Cat in the Hat, by Dr. Seuss [pseud.] (1957). Boston, Houghton Miffin Random House. (Adapted)

TEXT PAGE	SENTENCES	PICT PAGE
1	It was too wet to play.	1
	So we sat in the house.	
	On that cold, wet day.	
2	We did nothing at all.	3
3	And we did not like it.	
	Not one little bit.	
5	And then something went bump!	4/5
	How that bump made us jump!	
6	We looked and saw him	6/7
	The cat in the hat!	
	"Why do you sit there like that?" Said the cat.	
8	"I'll show you a lot of good tricks".	
11	But our fish said, "No! No!	10/11
	That cat should not be about	
	When your mother is out!"	
12	"My tricks are not bad"	12/13
	Said the Cat in the Hat.	
	"We can have fun, if you wish,	
	Up-up-up with the fish".	
13	"Put me down!" said the fish.	15
	"I do not wish to fall!"	
	Have no fear said the cat	
	As he stood on a ball.	
	With a book on one hand	
	And a cup on his hat.	

16	"Look at me now!" said the cat.	17
	"With a cup and a cake	
	On the top of my hat.	
	I can hold up the fish	
	And some milk on a dish."	
21	This is what the cat said....	20/21
	Then he fell on his head!	
25	"Now look what you did!	55
55	Your mother will find this mess!" said the fish.	
	"And this mess is so big, and so deep and so tall	
	We cannot pick it up.	
	There is no way at all!"	
57	And then!	56/57
	The Cat in the Hat was back.	
	"I'll show you another trick," he said.	
	And picked up things. He was quick.	
58	Then he said, "That is that."	59
	And then he was gone	
	With a tip of his hat.	
60	Then our mother came in.	60/61
	"Did you have fun?" She asked.	
	"What did you do?"	

Appendix G





Appendix H

PERCEPTION TEST - STIMULI TRANSCRIPT

TED JAGS	TED JAGS	TED JOGS
TAZZY HITS	TAZZY HITS	TAZZY HITS
CLIFF ADDS	CLIFFIE ADDS	CLIFF ADDS
TESSY WETS	TESSY WETS	TESSY WEDS
JULIE JIBS	JULIE JIGS	JULIE JIGS
PUPPIE EDITS	PUPPIE EDITS	PUP EDITS
JIMMY DEALS	JIMMY DEALS	JIMMY DEALS
FITCH FEELS	FITCHIE FEELS	FITCH FEELS
DODGE COSTS	DODGE COSTS	DODGE CASTS
HATCH WINS	HATCH WINS	HATCHIE WINS
CIB GAGS	CIB GABS	CIB GABS
GENIE KICKS	GENIE KICKS	GENE KICKS
CAPPIE NEEDS	CAP NEEDS	CAP NEEDS
RICKY MINDS	RICKY MINDS	RICK MINDS
BETTY AUDITS	BET AUDITS	BETTY AUDITS
MAUD MEETS	MAUDY MEETS	MAUD MEETS
PIPPY THUMPS	PIPPY THUMPS	PIPPY THUMPS
DAVE CHAPS	DAVE CHAPS	DAVIE CHAPS
JEFFY CUTS	JEFF CUTS	JEFF CUTS
DAFFIE BEATS	DAFFIE BITS	DAFFIE BEATS
PUDGE LEADS	PUDGIE LEADS	PUDGIE LEADS
REGGIE HOLDS	REGGIE HOLDS	REGGIE HOLDS
JEAN GABS	JEAN GABS	JEANIE GABS
ELSI JOGS	ELSI JAGS	ELSI JOGS
TEDDY CHAPS	TEDDY CHOPS	TEDDY CHOPS
DAWN LEAPS	DAWN LEADS	DAWN LEADS
DOLLY FANS	DOLLY FAGS	DOLLY FANS
JACKIE CHANTS	JACKIE CHANTS	JACK CHANTS
JUDE SHEDS	JUDY SHEDS	JUDY SHEDS

MEG EBBS	MEGGIE EBBS	MEGGIE EBBS
LIBBY AUCTIONS	LIBBY AUCTIONS	LIBBY AUCTIONS
DAFFIE CHEWS	DAFF CHEWS	DAFFIE CHEWS
LUKIE OWES	LUKE OWES	LUKE OWES
NED WETS	NED WETS	NEDDIE WETS
TRISH OFFERS	TRISH OFFERS	TRISH OFFERS
CATTIE SEEKS	CAT SEEKS	CAT SEEKS
MADGE VETS	MADGE VETS	MADGIE VETS
SEAN JETS	SEAN JOTS	SEAN JOTS
NADGE OPENS	NADGE OPENS	NADGE OPENS
POPPIE WEARS	POP WEARS	POP WEARS
DOTTIE CHEATS	DOT CHEATS	DOTTIE CHEATS
AMY NIPS	AMY NIPS	AMY NICKS
SAM PEAKS	SAM PEAKS	SAM PEAKS
KEITH CHOPS	KEITH CHOPS	KEITH CHAPS
CLIVIE PUTS	CLIVE PUTS	CLIVIE PUTS
TESS FADES	TESS FEEDS	TESS FEEDS
BESSY TIPS	BESSY TIPS	BESSY TIPS
PEG DIGS	PEGGY DIGS	PEGGY DIGS
MIDGIE TAGS	MIDGE TAGS	MIDGE TAGS
NATCH KEEPS	NATCH KEEPS	NATCH KEEPS
DANNY TAPS	DANNY TACKS	DANNY TAPS
BOBBY SETS	BOB SETS	BOBBY SETS
JOSH BETS	JOSHY BETS	JOSHY BETS
LUCY BEATS	LUCY BEATS	LUCY BITS
ANN TELLS	ANNIE TELLS	ANN TELLS
DUG ACTS	DUGGIE ACTS	DUG ACTS
LIV ROCKS	LIV RACKS	LIV ROCKS
DICK FAGS	DICK FAGS	DICKY FAGS
PAT CALLS	PATTY CALLS	PAT CALLS
HOFF THINKS	HOFF THINKS	HOFF THINKS
RITCH SHOOTS	RITCH SHUTS	RITCH SHOOTS
EVIE SHUTS	EVIE SHUTS	EVE SHUTS
DEAN GABS	DEAN GOBS	DEAN GOBS

JACK CASTS	JACK CASTS	JACK COSTS
TOBE LETS	TOBY LETS	TOBY LETS
ROY CHAPS	ROY CHAPS	ROY CHATS
MATTY ROBS	MATT ROBS	MATTY ROBS
TOM OWNS	TOM OWNS	TOM OWNS
LOVE NAPS	LOVE NABS	LOVE NAPS
BILLY TAGS	BILLY TAPS	BILLY TAPS
MITCHIE ADDLES	MITCHIE ADDLES	MITCH ADDLES
TINA BINDS	TINA BENDS	TINA BENDS

Appendix I

SITUATIONS (varying item underlined / middle column)

SITUATION A : **CVC + verb / CVC<u>V</u> + verb**

Cat puts Catty puts Cat puts

Variation of the position of the odd item - **TARGET**

1 CVCV / 2 CVC

a.	**CVC**	**CVC**	**CVCV**
b.	**CVC**	**CVCV**	**CVC**
c.	**CVCV**	**CVC**	**CVC**

1 CVC / 2 CVCV

d.	**CVCV**	**CVCV**	**CVC**
e.	**CVCV**	**CVC**	**CVCV**
f.	**CVC**	**CVCV**	**CVCV**

DIFFERENT

SITUATION B : CVC + <u>verb (vowel) (DISTRACTOR)</u>

Cat bends Cat b<u>a</u>nds Cat bends

SITUATION C : CVC + <u>verb (consonant) (DISTRACTOR)</u>

Cat seals Cat <u>z</u>eals Cat seals
Cat bags Cat ba<u>cks</u> Cat ba<u>gs</u>

SITUATION D : CVCV + <u>verb (vowel)) (DISTRACTOR)</u>

Catty bends Catty b<u>a</u>nds Catty bends

SITUATION E : CVCV + <u>verb (consonant)) (DISTRACTOR)</u>

Catty seals Cat ty <u>z</u>eals Catty seals
Catty bags Catty ba<u>cks</u> Catty ba<u>gs</u>

SITUATION F : CVC + verb (NO VARIATION)

Cat puts Cat puts Cat puts

SITUATION G : CVCV + verb (NO VARIATION)

Catty puts Catty puts Catty puts

DIST

Appendix J

TRAINING SESSION STIMULI TRANSCRIPT

DON'T SLEEP	DON'T SLIP	DON'T SLEEP
GOOD LOOK	GOOD LUCK	GOOD LUCK
FEEL IT	FEEL IT	FILL IT
LEAVE TODAY	LEAVE TODAY	LEAVE TODAY

BIG BANG	BIG BANG	BIG BANK
RICK CUTS	RICKY CUTS	RICK CUTS
ED KILLS	ED KILLS	ED KILLS
TOBE NEEDS	TOBY NEEDS	TOBE NEEDS
HUGE PEST	HUGE PAST	HUGE PAST
JEFF WINS	JEFF WINS	JEFFY WINS
MATTY KICKS	MATT KICKS	MATT KICKS
ASHY CHOPS	ASHY CHOPS	ASHY CHOPS

Appendix K

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes

PARTICIPANT'S NAME:_____

IN:

TRAINING SESSION

"Você vai ouvir sequências de 3 frases como *'Carol writes'* ou *'Edward plays'*. Circule o número 1, 2, 3, ou '0', na tabela abaixo, de acordo com o seguinte critério:

Se a primeira frase for diferente das outras, circule 1;
Se a segunda frase for diferente das outras, circule 2;
Se a terceira frase for diferente das outras, circule 3;
Se todas as frases forem iguais, circule '0'.

EXEMPLO:

Para os 4 conjuntos de 3 frases que você vai ouvir agora, as respostas já foram marcadas.

1.	1	**2**	3	0
2.	**1**	2	3	0
3.	1	2	**3**	0
4.	1	2	3	**0**

Agora você marcará as respostas de 6 conjuntos similares aos 4 anteriores, como um breve treinamento para a atividade alvo desta pesquisa.

5.	1	2	3	0
6.	1	2	3	0
7.	1	2	3	0
8.	1	2	3	0
9.	1	2	3	0
10	1	2	3	0
11	1	2	3	0
12	1	2	3	0

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes

PARTICIPANT'S NAME:_____

IN:

TRAINING SESSION

"You are going to hear sequences of 3 phrases as '*Carol writes*' or '*Edward plays*'. Circle 1, 2, 3, or '0', in the chart below, according to the following criteria:

IF the first phrase is different from the others, circle '1';
IF the second phrase is different from the others, circle '2';
IF the third phrase is different from the others, circle '3';
IF the fourth phrase is different from the others, circle '4';
IF all the phrases are the same, circle '0';

EXAMPLE:

Hear the 4 sets of 3 phrases. The answers have been marked for you.

1.	1	**2**	3	0
2.	**1**	2	3	0
3.	1	2	**3**	0
4.	1	2	3	**0**

Now, you are going to hear the 6 sets of phrases and mark your answers in the chart below. This is a short training for the activity.

5.	1	2	3	0
6.	1	2	3	0
7.	1	2	3	0
8.	1	2	3	0
9.	1	2	3	0
10	1	2	3	0
11	1	2	3	0
12	1	2	3	0

Universidade Federai de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Pesquisadora: Profª Rosana Denise Koerich
Orientadora: Profª Drª Barbara Oughton Baptista

PARTICIPANT'S NAME: _____

DATE: _____ AUGUST, 2000.

Não escreva aqui
IN:

ANSWER SHEET

De acordo com o treinamento prévio você ouvirá seqüências de 3 frases.

Circule '1', '2', '3', or '0'.

Não deixe nenhuma seqüência em branco.

Se a primeira frase for diferente das outras, circule '1';

Se a segunda frase for diferente das outras, circule '2';

Se a terceira frase for diferente das outras, circule '3';

Se todas as frases forem iguais, circule '0'.

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Researcher: Profª Rosana Denise Koerich
Adviser: Profª Drª Barbara Oughton Baptista

PARTICIPANT'S NAME: _____

DATE: _____ AUGUST, 2000.

Do not write here
IN:

ANSWER SHEET[16]

As in the previous training you are going to hear sets of 3 phrases.

Circle '1', '2', '3', or '0'.

Mark all the sequences.

If the first phrase is different from the others, circle '1';

If the second phrase is different from the others, circle '2';

If the third phrase is different from the others, circle '3';

If all the phrases are the same, circle '0'.

[16] Next page – first page of answer sheet

IN:

1.	1	2	3	0
2.	1	2	3	0
3.	1	2	3	0
4.	1	2	3	0
5.	1	2	3	0
6.	1	2	3	0
7.	1	2	3	0
8.	1	2	3	0
9.	1	2	3	0
10.	1	2	3	0
11.	1	2	3	0
12.	1	2	3	0
13.	1	2	3	0
14.	1	2	3	0
15.	1	2	3	0
16.	1	2	3	0
17.	1	2	3	0
18.	1	2	3	0
19.	1	2	3	0

Appendix L

Instructions

You are going to listen to sequences of 2 words like

'CHEAP PENS', 'BOB RUNS', 'TRUCK VEERS'.

Your task is to determine if the speaker inserts a vowel sound (in general /i/) at the end of the first word.

Please, do not consider other pronunciation mistakes.

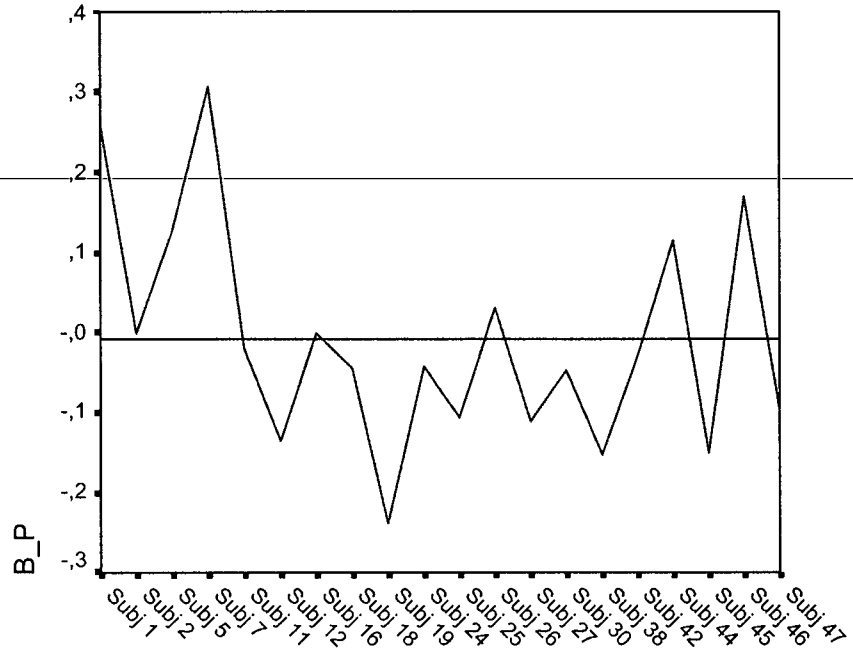
HIT **YES** if you hear the addition of a vowel after the first word

HIT **NO** if you don't hear the addition of the vowel.

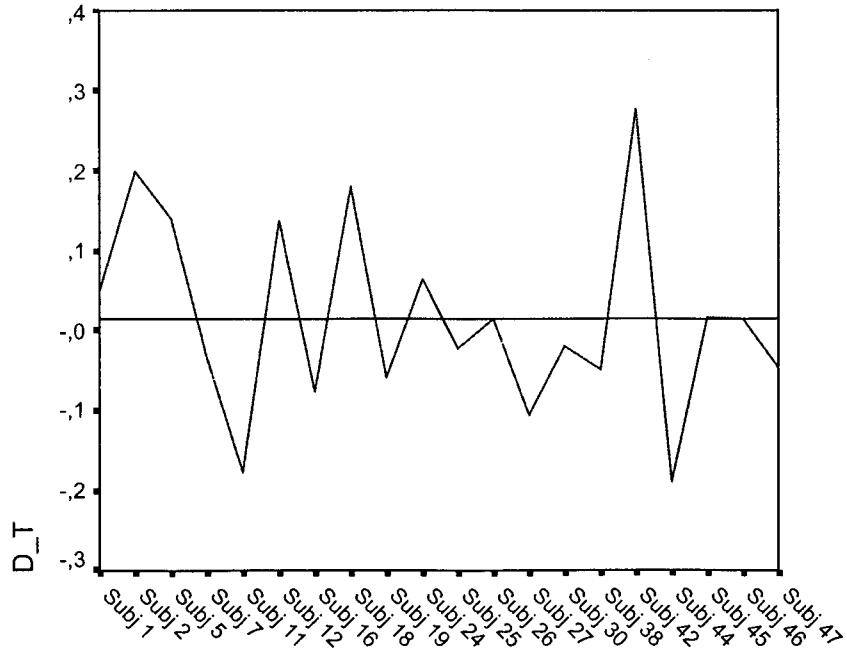
Appendix M

Sequence Graphs for Voicing Pairs – HYPOTHESIS 1

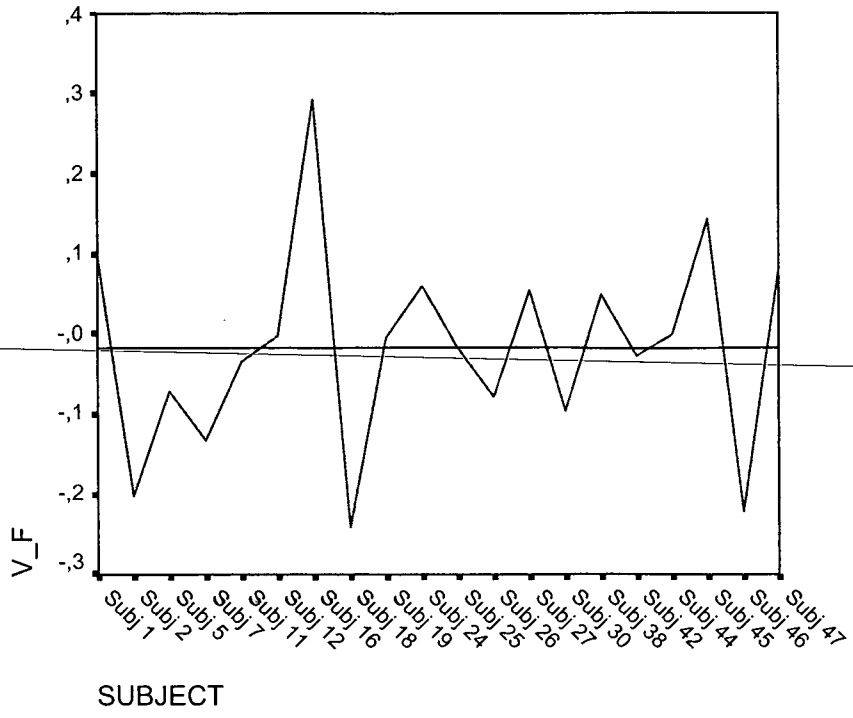
/b/-/p/



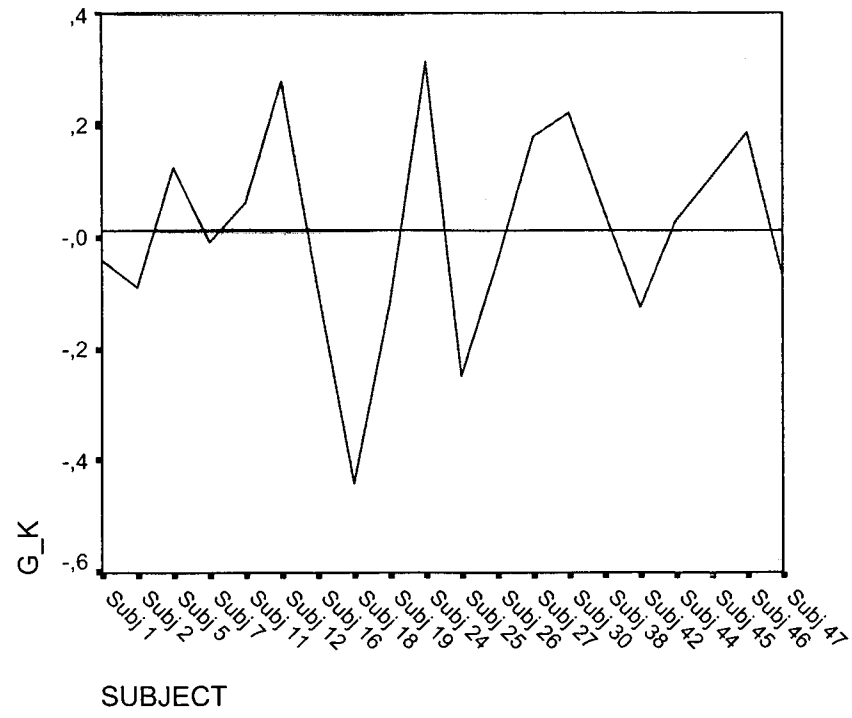
/d/-/t/



/v/-/f/


,4
,3
,2
,1
-,0
-,1
-,2
-,3
V_F
Subj 1
Subj 2
Subj 5
Subj 7
Subj 11
Subj 12
Subj 16
Subj 18
Subj 19
Subj 24
Subj 25
Subj 26
Subj 27
Subj 30
Subj 38
Subj 42
Subj 44
Subj 45
Subj 46
Subj 47
SUBJECT

/g/-/k/


,4
,2
-,0
-,2
-,4
-,6
G_K
Subj 1
Subj 2
Subj 5
Subj 7
Subj 11
Subj 12
Subj 16
Subj 18
Subj 19
Subj 24
Subj 25
Subj 26
Subj 27
Subj 30
Subj 38
Subj 42
Subj 44
Subj 45
Subj 46
Subj 47
SUBJECT