UNIVERSIDADE FEDERAL DE SANTA CATARINA

PÓS-GRADUAÇÃO EM LETRAS/INGLÊS E LITERATURA

CORRESPONDENTE

PERCEPTUAL TRAINING AND WORD-INITIAL /s/-CLUSTERS IN BRAZILIAN PORTUGUESE/ENGLISH INTERPHONOLOGY

MELISSA BETTONI-TECHIO

Tese submetida à Universidade Federal de Santa Catarina em cumprimento
parcial dos requisitos para obtenção do grau de

DOUTOR EM LETRAS

FLORIANÓPOLIS

Dezembro de 2008

Esta tese de Melissa Bettoni-Techio, intitulada *Perceptual training and word-initial /s/-clusters in Brazilian Portuguese/English interphonology*, foi julgada adequada e aprovada em sua forma final, pelo Programa de Pós-Graduação em Letras/Inglês e Literatura Correspondente, da Universidade Federal de Santa Catarina, para fins de obtenção do grau de

DOUTOR EM LETRAS

Área de concentração: Inglês e Literatura Correspondente
Opção: Língua Inglesa e Lingüística Aplicada

Dr. José Luiz Meurer
Coordenador

Dra. Rosana Denise Koerich
Orientadora e Presidente

BANCA EXAMINADORA:

Dra. Barbara Oughton Baptista (UFSC)
Examinadora

Dr. Michael Alan Watkins (UFPR)
Examinador

Dra. Denize Nobre Oliveira (CEFET-SC)
Examinadora

Dra. Gisela Collischonn (UFRGS)
Examinadora

Florianópolis, 01 de dezembro de 2008.

To Natalie

ACKNOWLEDGEMENTS

I would like to thank the National Council for Scientific and Technological Development (CNPq) for the financial support.

I would like to express my gratitude to the following people for their support and assistance in accomplishing this dissertation:

My advisor, **Prof. Dr. Rosana Denise Koerich**, for believing so much in me and being such a wonderful advisor, professor, researcher, boss, and FRIEND during the last five years (master and doctoral studies). My “partial independence” during my doctoral studies was entirely triggered by the spectacular guidance she has provided me during my master studies.

Prof. Dr. James Douglas Harnsberger (**Jimmy**) from the University of Florida in Gainesville**,** for the wise suggestions on the design of the perception tests and the generous offers of help. I would like to thank him for supporting me in my decision to go to Florida with Natalie and my decision to give up going to Florida due to my recently acquired job at CEFET-SC in Chapecó.

Prof. Dr. Barbara Baptista, Prof. Dr. Leda Tomitch, Prof. Dr. Adriana K. Dallagnello, Prof. Izabel Seara, and **Prof. Dr. Rosane Silveira** for all the inspiring classes and constant support during the last two years.

The members of the committee and **Dr. Michael Allan Watkins** for all the wise suggestions and corrections.

All the participants of this study for the time, the patience, and the interest. My special thanks to the participant of my pilot study, my dear friend and student **Claudete Slongo**.

My dear buddies at PPGI: **Andréia S. Rauber, Denise C. Kluge, Denize Nobre-Oliveira,** and **Mara Sílvia Reis.** You are great!

My workmates at CEFET: **Adriano Silva, Angela Silva, Fernando Gallego, Gilberto Thomas, Luciane, Marcelo Braga, Raquel (roommate), Renato (boss), Rosangela Marquezzi, Vejane** and **Sílvio Scartazzin**i, for the laughs, laughs, laughs…., the friendship, the interest, and the suggestions.

Finally, I especially thank my family: my mom, **Brígida**, my dad, **Onevio**, my sister, **Vanessa**, my husband, **Fernando**, and my daughter, **Natalie**. I would not be able or even want to do all that was necessary to reach this far without each of you…

And anybody I missed who deserves a mention!

Any shortcomings remain my own.

December 01, 2008.

ABSTRACT

PERCEPTUAL TRAINING AND WORD-INITIAL /s/-CLUSTERS IN BRAZILIAN PORTUGUESE/ENGLISH INTERPHONOLOGY

MELISSA BETTONI-TECHIO

UNIVERSIDADE FEDERAL DE SANTA CATARINA

2008

Supervising Professor: Dr. Rosana Denise Koerich

Research has shown that Brazilians tend to insert a vowel before word-initial /s/-clusters and to voice the /s/ depending on the following consonant features (e.g., Cornelian, 2003; Rauber, 2006; Rebello & Baptista, 2006). The present study investigated the perception and production of /s/-clusters in the Brazilian Portuguese/English interphonology and effects of perceptual training on learners' performance. The data collection was carried out through a pretest, a training phase, a posttest, and a retention test. Production was assessed by four reading tests and an interview. Perception was assessed by an AX discrimination task and by a forced-choice identification test similar to the task used in the training, but with additional words and recorded by an unfamiliar talker. The main objective of the study was to verify whether perceptual training would lead to improvement in perception and production. Transfer of training to a discrimination task and to untrained words was also tested. The training was designed following a high-variability approach (Logan et al., 1991) with difficulty gradually increasing throughout the training program. The training set consisted of two-alternative-forced-choice identification trials with immediate feedback and replay allowed after hitting the decision key. The stimuli consisted of phrases recorded by two Americans. The results showed that the phonological context did not significantly affect perception and production and that /s/+sonorant clusters were more difficult than /s/+stop clusters in both perception and production. There was improvement in identification, transfer to production, to discrimination and to untrained clusters. Improvement in identification, discrimination, and production was still detected in an eight-month follow-up test. Correlations between identification, discrimination, and production were stronger before training because the improvement in performance varied considerably among the tasks.

157 pages (excluding appendix)
34,816 words (excluding appendix)

RESUMO

TREINAMENTO PERCEPTUAL E ENCONTROS CONSONONTAIS COMEÇADOS EM /s/ NA INTERFONOLOGIA DO
PORTUGUÊS DO BRASIL/INGLÊS

MELISSA BETTONI-TECHIO

UNIVERSIDADE FEDERAL DE SANTA CATARINA

2008

Professora Orientadora: Dra. Rosana Denise Koerich

Estudos anteriores sobre /sC(C)/ em início de palavras mostraram que brasileiros tem a tendência de inserir uma vogal antes de /sC(C)/ iniciais e de vozear o /s/ dependendo dos traços fonológicos do som posterior (e.g., Cornelian, 2003; Rauber, 2006; Rebello & Baptista, 2006). O presente estudo investigou a percepção e a produção de /sC(C)/ iniciais na interfonologia do Português do Brasil/Inglês além de efeitos do treinamento perceptual na percepção e produção de /sC(C)/. A coleta de dados consistiu de um teste anterior, treinamento, um teste posterior e um teste de retenção. A produção foi acessada através de quatro testes de leitura e de uma entrevista. Percepção foi também acessada através de uma tarefa de discriminação AX e de um teste de identificação com alternativa dupla similar à tarefa de treinamento, com palavras extras e um locutor diferente. O objetivo principal era verificar se o treinamento perceptual provocaria melhora na percepção e na produção de /sC(C)/ iniciais. Transferência de treinamento para uma tarefa de discriminação e para palavras não treinadas também foi testada. O treinamento foi projetado seguindo uma abordagem de alta variação (e.g., Logan et al., 1991) com dificuldade gradualmente aumentando depois de cada bloco de treinamento. O programa de treinamento consistiu em questões de dupla alternativa com retroalimentação imediata e possibilidade de escutar o estímulo conforme vontade do participante até que uma resposta fosse dada. Os estímulos consistiam de frases gravadas por dois americanos. Os resultados mostraram que o contexto fonológico não afetou de forma significativa a produção e a percepção de /sC(C)/ e que /s/+soante sofreram mais modificações que /s/+plosiva tanto na percepção quanto na produção. Houve melhora na identificação e transferência de melhora para produção, discriminação e /sC(C)/ não treinados. Melhora na identificação, discriminação e produção ainda foram detectadas no teste administrado oito meses após o treinamento. Correlações entre identificação, discriminação e produção reduziram após o treinamento devido às diferenças na melhora de desempenho entre as tarefas testadas.

157 páginas (excluindo anexos)
34.816 palavras (excluindo anexos)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background to the study

The perception and production of nonnative contrasts is an important topic under investigation in the field of second language acquisition (SLA) (e.g., Baptista, 2006; Best, 1995; Flege, 1988, 1995; Watkins, 2000; Koerich, 2002; Silveira, 2004). The main reasons for carrying out studies in this area are to identify and to understand the difficulties foreign (FL) or second language (L2) learners have in pronouncing the target language; thus, providing support to further studies which can come up with ideas and pedagogical tools that can help learners overcome the difficulties pointed out.

A great number of pedagogically driven studies has shown that perceptual training can help learners improve their perception and production of the target language (e.g., Strange & Dittman, 1984; Jamieson & Morosan, 1986; Flege, 1989; Lively, Logan & Pisoni, 1993; Rochet, 1995; Bradlow, Pisoni, Akahane-Yamada & Tokura, 1997; Hardison, 2000, 2003, 2004; Trapp & Bohn, 2000; Yeon, 2004; Nobre-Oliveira, 2007; Bettoni-Techio & Koerich, 2008; among many others). These perceptual training studies have focused on specific sound contrasts that can cause difficulty for specific combinations of first and second or foreign languages. Most of the pedagogically driven studies afore-mentioned have focused on training Japanese speakers on the /r/ vs. /l/ contrast (e.g., Strange & Dittman, 1984; Lively, Logan &

Pisoni, 1993; Bradlow, Pisoni, Akahane-Yamada & Tokura, 1997; Hardison, 2000), but there is a growing body of research on other sounds with participants from other language backgrounds (e.g., /s/ vs. /z/ in Danish/English interphonology as in Trapp & Bohn, 2000; /tʃ/ vs. /tʃi/ and /dʒ/ vs. /dʒi/ in Korean/English interphonology as in Yeon, 2004; vowels in Brazilian Portuguese/English interphonology as in Nobre-Oliveira, 2007).

The present study shares the intents of the two groups of studies afore-mentioned. It seeks to investigate the perception and production of non-native contrasts, and effects of training. Word-initial /s/-clusters were defined as the target structure in the study because the acquisition of /s/-clusters is difficult in both first language (L1) and L2 (Yildiz, 2005). In Brazil, a few studies have been conducted on the production of word-initial /s/-clusters (e.g., Cornelian, 2003; Bonilha & Vinhas, 2005; Rauber, 2006; Rebello & Baptista, 2006). These studies found that the /s/ in /s/-stop clusters is frequently produced with an epenthetic vowel and the /s/ in /s/-sonorant clusters is produced with an epenthetic vowel and voiced. In Brazilian Portuguese (BP), these processes are found in loanwords, as for instance, *stress* (/s/-stop) pronounced and written with epenthesis – ‘estresse’ [istrɛsɪ], and *slogan* (/s/-sonorant) pronounced with an epenthetic vowel and voiced /s/ – [ɪzlogã]. Depending on idiolect, palatalization of /s/ is frequent; so that, *stress* may be pronounced as [ɪʃtrɛʃ] and *slogan* as [ɪʒlogã].

The relationship between perception and production of /sC(C)/ in BP/English interphonology, however, has only been investigated by Silveira (2002) and Bettoni-Techio (2008). The former found a positive correlation between perception and production considering type of cluster, that is, the clusters which were more accurately perceived were more accurately produced. The latter found that the more accurate a learner's ability is to identify and discriminate word-initial /s/-clusters, the more accurate his/her production will be of these clusters.

Explanations for the results obtained in the studies on word-initial /s/-clusters and on training effects have been provided with reference to two current models of cross-language speech perception and acquisition, Flege's (1995) Speech Learning Model (SLM) and Best and Tyler's (2007) Perceptual Assimilation Model for second language learners (PAM-L2) which originated from the Perceptual Assimilation Model (PAM) (Best, 1995). Both models relate perception and production of nonnative contrasts to some extent, suggesting that errors in the production of L2 sounds may be caused by misperception. Misperception along with transfer and articulatory constraints may influence the production of word-initial /s/-clusters by BP learners of English.

The SLM postulates that L2 sounds which are perceived as similar to L1 sounds are more difficult to be learned than L2 sounds which are perceived as new sounds. The PAM-L2 is in partial agreement with the SLM, suggesting that, besides perceptual assimilation patterns, two other factors may interfere with learnability: (1)

category-goodness rating[1] and (2) comparative relationships in the interphonology system such as distance between L1 sounds and L2 sounds in the interphonological space.

Both the SLM and the PAM-L2 claim that adults can acquire nonnative sound categories through L2 experience with quality and amount of L2 input being essential. Perceptual training programs have been used with second language learners because such programs direct learners' attention to their difficulties. The participants in the present study are FL learners, that is, learners who are studying a language in a place where it is not spoken outside the classroom. In their case, the exposure to the target language may be short and of poor quality. Perceptual training programs can help these learners by increasing the amount and quality of exposure to the target language.

Having in mind the potential benefits of perceptual training programs and the operational advantages of technological tools, I decided to design a computer-assisted perceptual training program. Students looking for self-study materials as well as students enrolled in distance courses can gain from the use of perceptual training programs (Wang & Munro, 2004) because they are efficient in reinforcing traces and consequently forming robust sound categories (Ellis, 2005) without constant assistance from a teacher. In order to improve perception and production of nonnative contrasts, L2/FL input has been provided by perceptual training using identification

[1] L2 sounds which are perceived as bad exemplars of an L1 category are more likely to be learned than L2 sounds perceived as good exemplars.

tasks (Bradlow, Pisoni & Akahane-Yamada, 1997; Hardison, 2004; Hazan, Sennema, Iba & Faulkner, 2005; among many others).

Bettoni-Techio and Koerich (2008) was the first study investigating effects of perceptual training on the pronunciation of /s/-clusters in BP/English interphonology. In this case-study, we found (1) a significant improvement in in the posttest and (2) a slight improvement from posttest to a five-month follow-up test. A strong significant improvement in production from pretest to posttest and from posttest to the five-month follow-up test was also shown.

Thus, in line with the studies mentioned above, the present study investigated (1) the production and perception of word-initial /s/-clusters; (2) the relationship between perception and production of word-initial /s/-clusters in BP/English interphonology; (3) the effects of identification perceptual training on the pronunciation of word-initial /s/-clusters; (4) transfer of perceptual training to perception of untrained /s/-clusters and tasks; and (5) the retention of improvement eight months after training. The study was innovative because to the best of my knowledge, (1) prior to the piloting of the present study, identification perceptual training had not been conducted using phrases in the trials; (2) no studies in Brazil had focused on perceptual training of syllabic structures; and (3) transfer to production had not been considered in terms of retention and generalization to semi-free speech.

1.2 Organization of the dissertation

The present dissertation consists of seven chapters. Chapters 2, 3, and 4 present an overview of the literature on the main areas of concern to the present study.

Chapter 2 presents issues related to speech perception and production. It starts by providing a brief overview of the Speech Learning Model (SLM) proposed by Flege (1995) and the Perceptual Learning Model (PAM-L2) proposed by Best and Tyler (2007). Then, it reviews studies on the relationship between perception and production and within the perception domain.

Chapter 3 reports perceptual training studies describing method, procedures, and innovations such as (1) the use of a high variability approach (e.g., Lively, Logan & Pisoni, 1993); (2) the introduction of visual cues in the training programs (e.g., Hardison, 2000); and (3) the manipulation of acoustic cues (e.g., Iverson and colleagues, 2005). Also, it discusses generalization of improvement to production and untrained talkers. Finally, perceptual training studies with a classroom focus are reviewed.

Chapter 4 reviews studies on the acquisition of word-initial /s/-clusters in BP/English interphonology. Then, a study on the relationship between perception and production of word-initial /s/-clusters and a perceptual training study on word-initial /sC/ are reviewed.

Chapter 5 describes the method used for carrying out the present study. It presents the research questions and hypotheses, and describes the participants, the material, the procedures adopted for collecting, analyzing and classifying data on perception and production of word-initial /s/-clusters. Also, the training program is detailed in terms of its design as well as its administration.

Chapter 6 consists of (1) a report of the results and of the statistical analysis carried out to analyze the data gathered; (2) a discussion based on the literature and on the hypotheses previously stated; and (3) a report of the participants' comments towards the training program.

Chapter 7 reports on the main findings of the study, discusses the limitations of the study and suggestions for further research, as well as pedagogical implications.

CHAPTER 2

PERCEPTION AND PRODUCTION

2.1 Introduction

In this chapter, I briefly review two speech learning models – the Speech Learning Model (SLM) proposed by Flege (1995) and the Perceptual Learning Model (PAM-L2) proposed by Best and Tyler (2007). Then, I review the most relevant research on the relationship between perception and production focusing on Brazilian Portuguese/English interphonology. In the last section of this chapter, I review some studies on the relationship between identification and discrimination.

2.2 Speech learning models

Research on L2 pronunciation has for a few decades focused on L1-L2 contrasts (e.g., Tarone, 1980/1987; Kluge, 2004; Alves, 2008). Whereas the Contrastive Analysis in its strong version has been widely criticized, it is currently a consensus among second language researchers that L1 plays an important role in predicting or explaining difficulty in the acquisition of an L2 (e.g., Tarone, 1980/1987; Major, 1998; Carlisle, 1991, 2001; Gass, 1996; Leather & James, 1996; Bettoni-Techio & Koerich, 2006; Baptista & Silva Filho, 2006; Koerich, 2006; among many others). Several hypotheses, models, and theories aiming at explaining when and how L1 influence operates in second language acquisition (SLA) have been proposed. The two most influential models designed concerning learning of L2 pronunciation – the Speech Learning Model (SLM) (Flege, 1995) and the L2 Perceptual Learning Model (PAM-L2) (Best & Tyler, 2007) developed from Best's Perceptual Assimilation Model (PAM) (1995) – are reviewed below.

2.2.1 The Speech Learning Model

Flege (1987) says that an L2 sound is classified as "new", when it is not perceived by the learner as equivalent to any sound of the L1 phonological space or "similar" when a sound is perceived as similar to an established L1 category. The new and similar concepts are the hub of the Speech Learning Model (SLM) proposed by Flege (1995).

Having L2 learners at their ultimate level of attainment in mind, the SLM attempts to explain difficulties in L2 pronunciation from the perspective that perception of L2 sounds happens through the filter of the L1 so that when an L2 sound is perceived as similar to an L1 sound, learners tend to categorize it as that L1 sound.

This process of equivalence classification may prevent learners from acquiring the proper cue-weighting values necessary for contrasting L1-L2 and L2-L2 sound categories. Cue weighting is the action of establishing a variable degree of importance to a certain cue. The weight and the cues that can be used to differentiate sounds and indicate that a set of sounds belong to one specific category or that two sounds cannot be considered exemplars of the same category vary across languages. For instance, whereas amount of aspiration is extremely important for discriminating

/b/ and /p/ in English, it is irrelevant for Brazilians who successfully use voicing in this discrimination.

The SLM predicts that through enough experience with the L2, a learner can acquire a sound category. Acknowledging the complexity of the task, the SLM predicts that adults are able to acquire a new language sound system. However, the SLM was designed considering the acquisition of an L2 in a natural setting, which implies a great amount of high quality exposure to the language. The training program designed for the present study intended to provide foreign language learners with the exposure necessary to make up for the adversities of learning an L2 in a foreign language context.

In addition to the strong influence of the L1 on the L2 learning process, Flege, Munro & Mackay (1996) found evidence that L2 Voice Onset Time (VOT) values also interfered in the L1 VOT values, which he considers to be existence of a single system. The SLM has been extensively tested, especially concerning vowels. For instance, Gallardo del Puerto, Lecumberri and Cenoz (2006) tested the influence of the degree of similarity in Spanish children's acquisition of English vowels and found that L2 vowels similar to L1 were harder to be identified than identical or new ones supporting the SLM's predictions. Baptista (2006), also investigating the acquisition of English vowels, carried out a longitudinal study with Brazilian Portuguese speakers who had arrived in the United States just before the experiment started. She found that the L2 vowels were not learned in isolation but, in fact, as part of a system – "vowels are related perceptually to one another" (p. 26) – and proposed the inclusion of a phonetic supercategory (Baptista, 2004) in the SLM. According to Baptista (2004), phonetic supercategories are larger phonetic categories that allow for an adequate distribution of the phonetic categories within the phonological space, assuring that the vowel categories include information concerning the relative positions and distance among them.

Among the factors that affect L2 learning, Flege has pointed out *age of arrival* (AOA), claiming that the younger the person is when he/she arrives in the country where the language is spoken the higher will be his/her ultimate attainment (Flege & Mackay, 2004). That is because the older the person is, the higher the state of development of L1 categories; thus, the less likely that L2 sound categories will be successfully formed. Another factor is length of residence (LOR), reflecting language experience in the foreign language environment, which is claimed to be essential to speech sound categorization. A third factor is relative amount of usage of L1 and L2, since, frequent activation of the L1 may hinder attainment of the native-like L2 pronunciation (Flege & Mackay, 2004). Finally, difficulties in the articulation of speech sounds may be a cause of problems in L2 learning (Flege, 1995), especially the learning of sequences of phones.

The four central postulates (P1 – P4) of the SLM (Flege, 1995) are reproduced and briefly discussed below.

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.

This postulate implies that adults can form L2 categories from acoustic-phonetic cues. However, children tend to have advantages in the learning process because (1) well-formed L1 categories can block L2 categorization; (2) amount of L1 experience is very important because it is the starting point of L2 acquisition; and (3) children and adults differ in how they 'perceive' and 'are perceived' by others.

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

This postulate refers to mental representations stored in memory which are the central elements of the SLM perception framework – phonetic categories. One of the greatest differences between the SLM and the PAM-L2 is that articulatory gestures are the central elements of the latter (see 2.2.2). The SLM states that L2 develops through the creation of new 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.

Exposure to a new dialect of one's own language may add information to an already established category eventually modifying the original category. Also, when an L2 sound is perceived as equivalent to an L1 sound, not only does the L2 sound tend to deviate from native production but the L1 sound produced by a bilingual speaker may differ from the sound produced by a monolingual speaker (e.g., VOT values as in Flege, 1996).

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

The VOT example is relevant to illustrate this postulate as well. The L1-L2 and L2-L1 interference can happen if sounds co-exist in a single phonological space. In this case, learners would have to maintain the distinction between (a) L1/p/ vs. L1/b/; (b) L2/p/ vs. L2/b/; (c) L1/p/ vs. L2/p/; (d) L1/b/ vs. L2/b/; (e) L1/p/ vs. L2/b/; and (f) L2/p/ vs. L1/b/.

The SLM claims that new phonetic categories can be established any time in life but the earlier the exposure to the L2, the more native-like the end state will be. Exposure leads the learner to attribute adequate weight to contrastive cues. Frequently, contrastive cues in one language are not contrastive in other languages and cause pronunciation problems even when highly salient at the phonetic level (e.g., /t/ vs. /tʃ/ as cited in Bettoni-Techio, 2005). The PAM-L2, among other goals, seeks to explain why even salient auditory contrasts sometimes do not lead to the formation of new sound categories. In the next subsection, the PAM-L2 is reviewed concerning some differences to the SLM.

2.2.2 The Perceptual Learning Model – L2

Best (1995) proposed a cross-language assimilation model – the Perceptual Assimilation Model (PAM) which established correspondences between L1 and L2 sound categories. The PAM focuses on naïve speakers, and, is able to predict assimilation at an initial stage, but fails to describe language development. Best and Tyler (2007) adapted the PAM to predict learnability of L2 sounds from the category assimilation types proposed in the PAM. The PAM, thus, was the basis for the PAM-L2. Below, the PAM-L2 is described and some of the main distinctions and similarities between it and the SLM are pointed out.

Both models state that adults can learn the sounds of a foreign language. The PAM follows a direct-realistic approach which means that sounds are perceived through articulatory gestures. Claiming that adults can learn L2 sounds means that the capacity of refining one's perception and production of speech sounds remains intact throughout life. Evidence for this capacity is present in L1 situations when people make contact with different dialects and unconsciously modify their own idiolect in the direction of the new sounds. A situation like that serves as evidence for another similarity between the PAM-L2 and the SLM – both depend on the assumption that L1 and L2 sounds co-exist in a single phonological space.

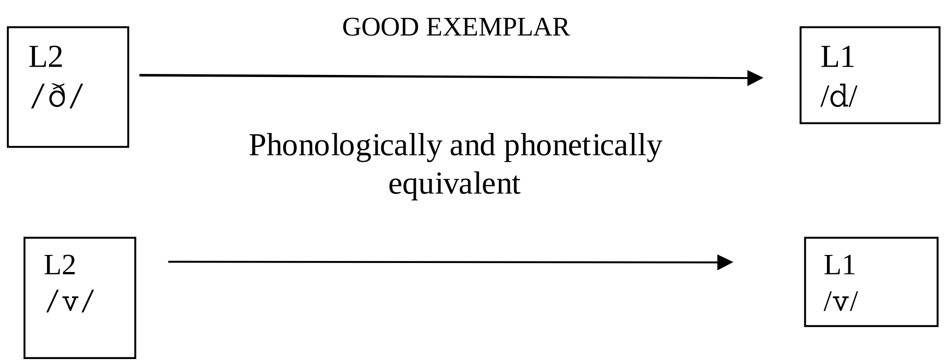
From the perspective of the PAM, categorization is not merely phonetically-driven. Equivalence can also happen at the phonological and/or lexical-functional levels. When learners do not perceive the contrast [t-tʃ] and start producing the two sounds interchangeably, it does not mean that they think [t] and [tʃ] are phonetically equal, but that they are phonologically equal and occupy the same position in the syllable – and thus are allophones of the phoneme /t/, as they are in BP. Also, when Brazilians fail to discriminate English initial sound of 'red' (/rɛd/) and Brazilian Portuguese initial sound of 'rei' (/heɪ/), it does not necessarily mean

Brazilians do not perceive the differences between /r/ and /h/. It implies that because the sounds have the same orthographic representation and occupy the same position in the syllable, they are assigned to the same category, irrespective of their acoustic differences.

The following representation of way the PAM-L2 predicts learning in four types of assimilation proposed by the PAM was developed with basis on Best and Tyler (2007).

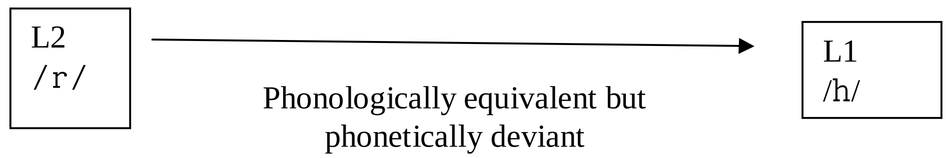
1) *Only one L2 phonological category is perceived as equivalent (perceptually assimilated) to a given L1 phonological category.*

a)



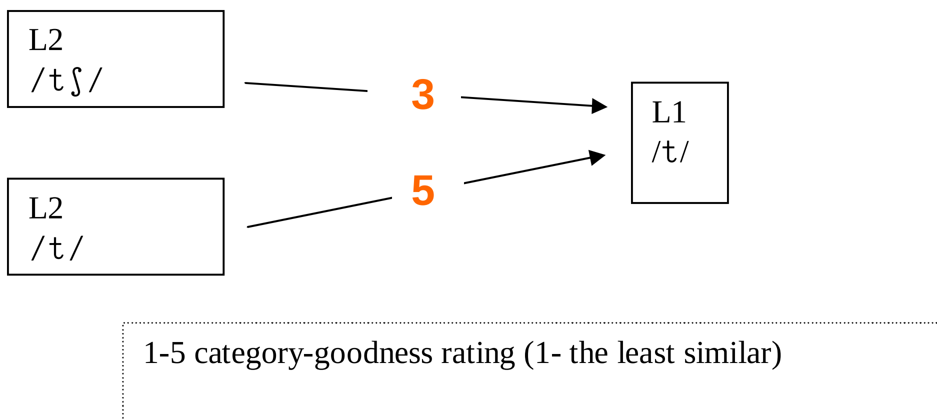
The discrimination between /ð/ vs. /v/ is good; therefore, the contrast will not hinder communicability to a great extent, and learning of /ð/ is not probable.

b)



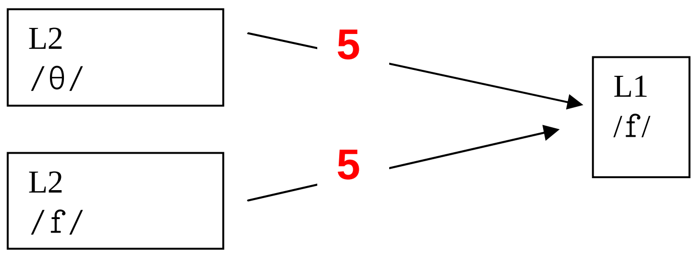
The discrimination between /r/ vs. /h/ is good. Since /r/ and /h/ are phonologically equivalent, the L2 sound may be taken as an allophone of the L1, and again, learning is not probable.

2) *Both L2 phonological categories are perceived as equivalent to the same L1 phonological category, but one is perceived as being more deviant than the other.*



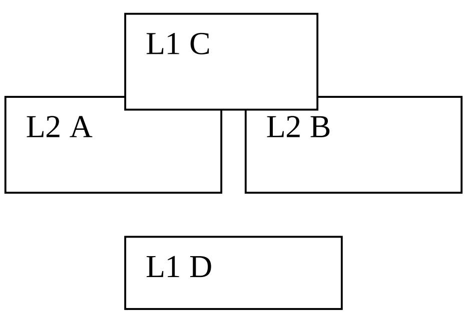
Discriminaton between /t/ and /tʃ/ is good but not as good as in the case of /ð/ vs. /v/. Learning of /tʃ/is more likely than of /t/. Continuous exposure may lead the learner to perceive the lexical-functional contrasts between /tʃ/ and the L1 category and to create a new phonological category.

3) *Both L2 phonological categories are perceived as equivalent to the same L1 phonological category, but as equally good or poor instances of that category.*



Initial discrimination between /θ/and /f/is poor, that is, words such as *three* and *free* would be perceived as homophones. Before establishing a new phonological category for these sounds, a new phonetic category for at least one of them has to be learned. The sound will be learned if there is a high frequency of words containing one of the sounds and a great necessity for the distinction to contrast words and utterances which are important for communication. Learning depends on the category-goodness rating (how good an exemplar of the L1 category the L2 sound is perceived as) as well, but all in all it is not probable.

4) *No L1-L2 phonological assimilation.*



In terms of the SLM, the sounds will be perceived as "new" and therefore they would be easy to learn. The PAM-L2, however, considers the distance between the L1 and L2 categories in the phonological space as determinant of the learnability because discrimination will depend on the similarity between the L2 sounds and the sounds in the L1 phonological space. For instance, the L2 categories above may merge into one new category. Initial discrimination and subsequent learning will depend on the necessity of learning the contrast as imposed by language usage, word frequency and the impossibility to discriminate words and utterances.

2.3 The relationship between perception and production

The relationship between perception and production has instigated researchers for a few decades already. In order to understand this relationship, it is necessary to understand some basics of L2 speech perception. According to Jusczyk, Hohne and Mandel (1995), small children experience an increase in the sensitivity to finer distinctions between sounds relevant to their specific native language as their ability to understand words in the native language develops. As children start learning words, sound categories are formed. Listeners rely on these phonetic categories to interpret aural stimuli. Several studies have shown that even when stimuli form a physical continuum, produced by manipulating acoustic properties of sounds, perception is categorical rather than continuous (e.g., Liberman, Harris, Hoffman, & Griffith, 1957; Pisoni & Tash, 1974).

Flege (1988) adopted the term 'equivalence classification' to refer to the allophonic association between L2 and L1. Usually, L2 and L1 sounds are misperceived as similar when learners mistakenly transfer L1 cue weighting patterns to the target language. The author claims that, on the one hand, equivalence classification is an important mechanism for L1 acquisition, since it enables us to identify the same phone produced by several talkers in different conditions and points in time as belonging to the same category; however, on the other hand, it may hinder phonetic category formation in an L2, leading to foreign accent (as explained in section 2.2.1). Flege's SLM (1995) explores the relationship between perception and production from this perspective.

The differences in the perception of French by English and Portuguese speakers can provide an example of language-specific cue weighting. Whereas Portuguese speakers perceive French /y/ as the Portuguese /i/, English speakers perceive French /y/ as the English /u/ (Rochet, 1995). Another example is /θ/, perceived as /t/ by many literate Brazilians (Reis, 2006) and as /f/ by illiterate Brazilians[2] whereas it is perceived as /s/ by German speakers (Hancin-Bhatt, 1994, 1997). These substitutions in perception are likely to lead to misproduction.

Spolsky (1989) establishes a relationship between speech perception and production in the *Sound Discrimination Condition*. He states that:

> The better a learner can discriminate between the sounds of the language and recognize the constituent parts, the more successful his or her learning of speaking and understanding a second language will be.
> (p. 20)

---

[2] The PAM-L2 mentions equivalence classification triggered by the same orthographic representation. This might explain why literate Brazilian learners substitute the interdental fricative for the alveolar stop whereas young children choose the acoustically similar sound /f/.

Spolsky points out that Blickenstaff (1963) “showed that pitch discrimination correlated with foreign language attainment at beginning levels in high school, but became less significant at the more advanced levels” (p. 106). This finding supports the view that perception is extremely important at initial stages of acquisition and that perception and production may not develop at the same rate. Second language research on the relationship between perception and production has shown that perception tends to precede production, but learners tend to reach higher ultimate attainment in production than in perception (Strange, 1995). That is, perceptual difficulties may remain even after production has been mastered.

It seems that perception is important as basis for production improvement. The SLM claims that perception is a condition for production but not the motivator of all L2 production errors. Flege (1995; 1997) acknowledges the role of articulatory complexity and linguistic markedness as important factors contributing to L2 production errors. The author uses /s/-clusters as an example of articulatory complexity leading to production inaccuracy rather than misperception. However, many Brazilian learners who mispronounce word-initial /s/-clusters in English cannot perceive the difference between the accurate and the inaccurate productions indicating that even for word-initial /s/-clusters misperception may trigger misproduction.

Studies investigating perception of L2 sounds have used three main types of data gathering instruments: (a) identification, (b) discrimination, and (c) imitation. Imitation is the least frequent type of perception test in the literature. In identification tasks, listeners are supposed to label or select a response corresponding to a stimulus. In discrimination tasks, listeners have to determine whether the stimuli presented are the same or different. Koerich (2002) describes three main types of discrimination tasks: (a) the oddity discrimination task, where one of three stimuli presented is different; (b) the ABX task, where A is different from B and X is identical to either A or B; (c) the same-different AX procedure, where A is either the same or different from X.

In Brazil, the first studies on the relationship between perception and production of L2 sounds used adaptations of the Categorial Discrimination Test (CDT) developed by Flege, Munro and Fox (1994). The CDT is a type of oddity discrimination test that is marked by the presence of catch trials (when all tokens are the same). Also, the tokens within the trials are always produced by a different talker which is meant to lead learners to pay attention to relevant acoustic cues that can be used to discriminate the sounds in question.

Koerich (2002) was the first study to investigate the relationship between perception and production in BP/English interphonology. Because of the difficulty CVC words tend to pose to Brazilian learners, word-final consonants were chosen as object of the study. The perceptual contrast investigated through an adaptation of the CDT was CVC vs. CVCi. Production of CVC was assessed through a topically unrelated sentence reading test. Silveira (2004) also investigated perception of word-final consonants by Brazilian learners of English following Koerich's methodology.

Both studies found some correlation between perception and production of word-final consonants at an early stage of SLA.

Kluge (2004) assessed production of word-final nasals through a sentence reading test and innovated regarding perception tests by using both an adaptation of the CDT and an identification test. The author found that scores were higher for the identification test and that there was a higher correlation between production and discrimination than between production and identification. However, the discrimination and identification tests did not test exactly the same constructs. In the discrimination test, learners had to discriminate between final /m/ and final /n/, and in the identification test learners had to identify final /m/ and final /n/ as native-like or nonnative-like. Thus, maybe the identification test should have been classified as a judgment task. Bearing the identification/judgment distinction in mind, it can be said that a higher correlation was found between accurate production and the discrimination of the contrast than between accurate production and the ability to judge the nativelikeness of words ending in final /m/ and /n/.

Reis (2006) examined the relationship between perception and production of interdental fricatives by Brazilian learners of English at different proficiency levels. Production was assessed through a text reading task, a sentence reading task and a story retelling task. Perception was assessed through a general pronunciation error test, an adaptation of the CDT and a forced-choice identification test. Unlike the other studies reviewed, no correlation between perception and production was found. Also, language proficiency, or experience as reported by the author, was found to influence the results. However, it is important to point out that interdentals, the target sounds of the study, can be considered special since they are absent in many native-speaker idiolects[3] and discrimination of /θ/ and /ð/ is difficult even for native speakers, as shown by Reis' results.

Bettoni-Techio, Rauber and Koerich (2007) investigated the relationship between perception and production of word-final alveolar stops. Perception was tested through an adaptation of the CDT having phrases as tokens and through a discrimination test where the targets were (1) final [tʃ], [tʰ], [tɪ] and [t˺], and (2) final [dʒ], [dʰ], [dɪ] and [d˺]. Production was assessed through a reading test of topically unrelated short sentences. Significant correlations showed that the better a learner perceives the target sounds, the more accurate his/her production is. Also, /t/ was more frequently palatalized and aspirated than /d/, and palatalized and aspirated productions were frequently less discriminated from [t] than [d]. Likewise, /d/ was more frequently epenthesized than /t/ and epenthesized productions were less frequently discriminated from [d] than [t]. Thus, there was also a correlation between voicing of the target sounds and type of error.

Piza (2007) investigated the relationship between perception and production of word-final consonants innovating in two main ways. Firstly, the participants of her study were children aged 4 and 5 instead of the typical young adults and adults, and secondly, she did not use adaptations of the CDT. The data gathering instruments

[3] According to Best and Tyler (2007), some New Yorkean dialects substitute /d/ for /ð/.

were an AX discrimination test (similar or different), an imitation test, a picture-naming test and a free production test. The data was collected with the aid of a computer software specially designed for the experiment. Piza showed a positive correlation between the results of the imitation and production tests; however, no correlation was found between the results of the AX test and production.

Pronunciation of vowels is another great difficulty in BP/English interphonology. Rauber (2006) examined whether there was correlation between perception and production of /i, ɪ, e, æ, u, ʊ/ having eighteen highly proficient English learners as participants. Production was tested by a sentence reading test containing CVC words where V was one of the six vowels tested, and perception was assessed by a forced-choice identification test with synthesized stimuli. Production was acoustically analyzed in relation to formants and duration. Results showed that perception of the target vowels tends to be more accurate than production. Also, the vowels which were more frequently misperceived were the ones more frequently mispronounced.

The relationships within the perception domain have not been extensively investigated in BP. In the next section, I present the theoretical basis of the studies on identification and discrimination relationship and some of the most influential research carried out on the area so far.

2.4 Identification and Discrimination

The PAM, following a direct-realistic approach, claims that patterns of assimilation of L1 and L2 phones can predict discrimination performance. For instance, when two L2 sounds are perceived as one L1 sound, discrimination will be poor, whereas when two L2 sounds are assimilated to two different L1 categories, discrimination will be excellent.

Guion, Flege, Akahane-Yamada and Pruitt (2000) investigated the relationship between identification and discrimination of English sounds by native speakers of Japanese. Two experiments were carried out. In the first experiment, near-functional Japanese monolinguals performed an identification test and a rating for goodness-of-fit test. In the second experiment, low-, mid-, and high-experienced Japanese learners of English took a discrimination test designed with the same stimuli used in the first experiment. The results indicated that the perceived distance between L1 and L2 sounds by monolinguals could predict discrimination by L2 learners. Also, by comparing the different groups from Experiment 2, it was shown that the L1-L2 distance as perceived by the naïve participants from Experiment 1 could predict learnability.

Harnsberger (2001) set out to investigate the PAM's predictions by testing identification and discrimination of Malayalam, Marathi, and Oriya nasal consonants with different places of articulation by seven groups of functional monolinguals of seven different L1s. Harnsberger's results did not show a strong support for the PAM concerning some predictions; for example, category-goodness assimilations were not significantly different in discriminability from the two-category assimilation type.

However, few examples of category-goodness assimilations were found in the study, and the author stated that this may have affected the results. To account for the fact that category-goodness ratings alone were not effective in predicting perceptual categories, Harnsberger proposed "an alternative model of cross-language speech perception in which the discriminability of non-native contrasts is a function of the similarity of non-native sounds to each other in a multidimensional phonologized perceptual space" (p. 489).

In line with Harnsberger's study, Wayland (2007) affirmed that in order to really find support for the PAM's predictions one would have to determine which the optimal pair of identification and discrimination tests is. The author found a stronger relationship between identification and discrimination when tasks were prepared maintaining the same stimuli presentation format. She claimed that in order to find this optimal pair, it is necessary to thoroughly understand the demands the identification and discrimination tasks pose on working memory, as well as how listeners process the tasks. Wayland suggested that acoustic and articulatory-phonetic properties, which are the basis of the PAM, "do not necessarily predict perceived assimilation patterns" (p.216) and Harnsberger (2001) claimed that "discrimination is a function of differences between the stimuli (as opposed to category-goodness difference) and their location in perceptual space relative to category prototypes" (p. 499).

2.5 Conclusion

The PAM-L2 and the SLM predict in that when an L2 sound is perceived as very similar to an L1 sound, the sound will be relatively difficult to be learned. They also claim that there is a single system for the L1 and L2 and that the relationship between L1 and L2 categories is the key to learning predictions. The PAM-L2 adds that when the lack of perception of the contrast hinders communication, the L2 sound is likely to be learned. Both models agree that exposure and experience is very important to success in learning and that L2 sounds perceived as bad exemplars of or different from an L1 category are more likely to be learned than L2 sounds perceived as good exemplars or similar.

The PAM-L2 suggests that, besides perceptual assimilation patterns, two other factors may interfere with learnability: (1) category-goodness ratings, with L2 sounds perceived as bad exemplars of one L1 category being more likely to be learned than L2 sounds perceived as good exemplars, and (2) comparative relationships in the interphonology system, such as distance between L1 sounds and L2 sounds, in the interphonology space, as had been proposed by Harnsberger. Also, the PAM-L2 adds that equivalence classification happens not only in terms of phonetic equivalence. The PAM-L2 proposes lexical-functional equivalence as an active mechanism responsible for failure or success in the learning endeavor. In Best and Tyler's (2007) words, "language relevant speech properties are differentiated not only at the phonetic level but also at the higher-order phonological level, as well as at the lower-order gestural level" (p. 25).

Most studies on the relationship between perception and production investigating Brazilian Portuguese learners of English have found positive correlations between the two abilities. Studies investigating the relationship within the domain of perception aim at testing the PAM and thus, have as subjects naïve speakers, not learners as it is the case of the studies on the relationship between perception and production. Some of the findings from these studies have been incorporated by Best and Tyler in the PAM-L2.

The implications of the SLM and the PAM-L2 for the present study are that adults are able to learn new sound categories and that exposure to the contrasts is very important for learning to take place. Also, when learners use different cues from native speakers in discriminating pairs of sounds and are successful, they end up never relying on the same cues of native speakers. This happens because the absence of learning does not necessarily imply inability to learn new sounds, but may be due to lack of necessity to do so or to insufficient exposure.

There is a need for calling attention to the specific contrast in question so that it acquires relevance and the learner feels the necessity for learning in the perceptual field so that production can be improved as a consequence. Usually, misperception leads to misproduction, which argues for the point of view that perception precedes production. The PAM-L2 emphasizes that higher-order levels have to be invoked in the actually phonological categorization, but also claims that for the phonological category to be formed there is sometimes the need of establishment of a phonetic category beforehand (p.30).

The perceptual training program designed for the present study had the goal of contributing to the formation of new categories (SLM) or the tuning to a new contrast (PAM-L2) by providing extensive exposure to the contrast and immediate feedback on its identification. In the next chapter, I review the most relevant studies on perceptual training that have been published so far.

CHAPTER 3

PERCEPTUAL TRAINING

3.1 Introduction

Technology has brought advances to computer-assisted language learning in the form of self-study and distance courses, in which pronunciation acquisition and improvement is, in many cases, one of the abilities explored. According to Wang & Munro (2004) pronunciation perception training programs included in such self-study materials are efficient in reinforcing traces left in memory by sounds and, consequently, help to form what Ellis (2005) calls 'robust sound categories'. Among the tasks used in L2 sound perception training materials, identification has been reported as a successful tool (e.g., Jamieson & Morosan, 1986; Rochet, 1995; Bradlow, Pisoni & Akahane-Yamada, 1997; Hardison, 2000, 2003, 2004, 2005; Hazan, Sennema, Iba & Faulkner, 2005; Nobre-Oliveira, 2007; among others).

The basic procedure in these tasks is to get learners to listen to one stimulus and identify the target sound as one of two sounds being trained. The stimuli usually consist of minimal pairs of words containing the target phonemes in multiple word positions, and are produced by multiple talkers, in multiple phonological contexts following a high-variability approach (e.g., Logan, Lively & Pisoni, 1991). If the learner accurately identifies the sound, s/he listens to the following trial; otherwise, the correct word blinks on the screen and the stimulus is repeated. Studies have not been consistent regarding the characteristics of perceptual training programs. In general, they lasted from one to eight weeks, and have included three to fifteen sessions of around thirty minutes.

In this chapter, I review several perceptual training studies[4]. The review is organized chronologically for the most part. However, in order to group the studies according to differences in terms of procedure and innovations presented as well as the hypotheses tested, the timeline was not strictly respected.

3.2 Perceptual training studies in the 1980s

Perceptual training studies have given special attention to the /r/ vs. /l/ contrast, with Japanese speakers as participants (e.g., Logan, Lively, & Pisoni, 1991; Lively, Logan, & Pisoni, 1993; Bradlow, Pisoni, Akahane-Yamada & Tohkura, 1997), but other nonnative contrasts have been investigated as well (e.g., /θ/ vs. /ð/ as in Jamieson & Morosan, 1986; /t/ vs. /d/ as in Flege, 1989; /s/ vs. /z/ as in Trapp & Bohn, 2000; CV+alveolopalatal vs. CV+alveolopalatal+V as in Yeon, 2004).

One of the first studies investigating the effects of perceptual training on second language acquisition was carried out by Strange and Dittman (1984). The authors investigated the effects of discrimination training with immediate feedback on the /r/ vs. /l/ contrast in minimal pairs such as *rock* and *lock.* Eight Japanese speakers participated in the training, consisting of fourteen to eighteen sessions of seven blocks of eighteen trials of synthesized stimuli each session. The whole

[4] The training studies carried out on word-initial /s/-clusters are reviewed in Chapter 4 where the acquisition of /s/-clusters by L2 learners is discussed.

training program took approximately three weeks. Even though Strange and Dittman's study was groundbreaking, the improvement in perception was limited and the discrimination task was found to call attention to within-category distinctions. Furthermore, no generalization to natural stimuli was found.

In order to avoid directing attention to within-category distinctions, Jamieson and Morosan (1986) carried out a perceptual training study using an identification task with immediate feedback. Twenty Franco Canadian speakers were trained on the distinction between the English voiced interdental fricative and its voiceless counterpart in synthetic CV syllables. The training, which consisted of twelve sessions of three to eight blocks each, with twenty trials per block, took approximately ninety minutes. The training was adaptive, meaning that each participant worked at their own pace. Another difference between Jamieson and Morosan's training and the one conducted by Strange and Dittman was the adoption of the fading technique. The fading technique consists of enhancing the contrast in the beginning of the training and gradually reducing it towards the end of the training. In Jamieson and Morosan's study, the contrast enhancement was obtained by an increase in the fricative duration in the synthetic CV tokens. The contrast was perceived more easily in the enhanced condition and the duration of the fricative was gradually reduced during the training program until the normal duration was presented. The identification training was successful since there was improvement in perception and generalization of improvement to natural stimuli.

The voicing contrast was also the object of Flege's (1989) identification training study. Flege trained sixteen Chinese speakers on the /t/ vs. /d/ contrast in natural words with immediate feedback. Four conditions were tested by varying the number of words and the number of trials. The most effective condition consisted of one mono-blocked session of four words with several trials, which indicates that repetition is important for the formation of a trace. In this study, there was improvement in the perception of trained words, and this improvement was transferred to words not included in the training program.

3.3 More recent perceptual training studies

Wang and colleagues (1999) changed the focus of the training studies from segments to suprasegmentals by training eight Americans in the perception of Mandarin tones. The identification perceptual training with immediate feedback consisted of natural monosyllables produced by four talkers and presented in increasing difficulty in eight forty-minute sessions during a period of two weeks. The results indicated a 21% improvement in perception with transfer to novel words and novel talkers. A six-month retention test revealed that the improvement was lasting.

Wayland and Guion (2004) also focused on training tones. Chinese and native English speakers were trained on the identification and discrimination of mid- vs. low-tone contrasts in Thai. Participants listened to five talkers producing eight pairs of phrases. The training consisted of five thirty-minute sessions during five days. There was immediate feedback after each trial. The Chinese speakers outperformed the native English speakers in identification, discrimination and in improvement. The conclusion drawn from the results was that previous experience with tones in one language facilitates the learning of tones from other languages.

Wayland and Li (2008) also trained Chinese and English speakers on the discrimination of mid vs. low-tone contrast in Thai. The goal of the study was to evaluate effects of two perceptual training procedures: (1) two-alternative forced-choice identification procedure, and (2) categorial discrimination (same or different) procedure. Since the 1980s, categorial perceptual training had been somewhat avoided because it is likely to call attention to within-category distinctions. However, the authors, based on Strange (1992), point out the distinction between an AX discrimination task and a categorial discrimination task. They claim that in a categorial discrimination task, the stimulus is always physically non-identical (e.g., produced by a different talker), in contrast to a simple same or different AX task where the attention is turned to whether the stimulus was repeated.

The participants were 30 Mandarin Chinese and 21 American English speakers with no prior experience with Thai. The stimuli were 5 minimal pairs shown in a pre-pilot to be the most challenging mid vs. low-tone contrasts among all contrasts possible. The participants from both groups took the pretest, which consisted of an AXB discrimination task, two sixty-minute training sessions, and a posttest identical to the pretest.

For the identification training group, the twenty first trials were used for familiarizing participants with the object of the training program, the even-numbered trials belonging to one type of tone and the odd-numbered trials to the other type of tone. Then, the following sixty trials were randomly presented and participants had to decide which type of tone they had heard. In both phases, participants could listen to each stimulus as many times as they wished before selecting the decision key. For the discrimination training group, the first phase of twenty trials also consisted of familiarization, as in the identification training. The even-numbered trials were two productions of the same type of tone (e.g., low-tone vs. low-tone and mid-tone vs. mid-tone) produced by different talkers and the odd-numbered trials were realizations of different types of tone (e.g., low-tone vs. mid-tone, mid-tone vs. low-tone). In the second phase, sixty trials of same and different tones were randomly presented. Participants could listen to each trial as many times as they wished before pushing the decision key.

A small numerical but non-significant advantage was found for the identification training group for both Mandarin Chinese and American English speakers, suggesting that paying exclusive attention to acoustic features may be more productive than focusing on whether the tokens belong to same or different categories. Also, the Mandarin Chinese group outperformed the American English group, showing again a positive effect of prior experience with tone contrasts as in Wayland and Guion.

Another study on the training of suprasegmentals is Yeon (2004), which focused on the syllable. The study investigated effects of perceptual training on avoidance of vowel epenthesis, focusing on final alveopalatals in Korean/English interphonology and testing transfer and three-month retention of perceptual training to production. Production was assessed through a word-reading test and a picture naming task. Perception was assessed through identification tests. The training consisted of three thirty-minute sessions of identification tests per week during three weeks. The stimuli were sixty-three minimal pairs consisting of (a) words ending with an alveolopalatal, and (b) words ending with an alveolopalatal followed by a vowel. Yeon found immediate positive results in perception and detected improvement in production only in the three-month retention test. The author claimed that participants at lower levels of proficiency benefited more from the training.

Hardison (2004) incorporated visual aids in the training of suprasegmentals. Native English speakers participated in a three-week computer-assisted training program on French pitch contours. The training consisted of thirteen sessions of about forty minutes each, with feedback corresponding to real-time visual displays of pitch contour. Sixteen American high beginner and low intermediate learners of French (1) read twenty short sentences in French, (2) undertook a training program of ninety sentences, (3) re-read the twenty short sentences previously recorded, and finally (4) took an additional generalization test. In the training, participants read each sentence and its pitch contour appeared on the computer screen simultaneously to the reading. Following that, participants heard the same sentence produced by a native French speaker and the corresponding pitch contour was displayed on the screen. After that, in an additional window, the two pitch contours were overlaid in ~~a~~ contrasting color. Receiving this feedback, participants, then, reread the sentence. Results indicated a significant improvement in prosody and segmental accuracy.

Hardison (2000, 2003, 2005) carried out a series of perceptual training studies involving the introduction of the visual modality in terms of a talkers' face. In

Hardison (2000, 2003), (1) eight Japanese speakers and eight Korean speakers received audiovisual perceptual training, (2) eight Japanese and eight Korean speakers received auditory-only training, and (3) eight Japanese and eight Korean speakers language received no training, serving as a control group. The goals of the studies were to analyze the training modalities as well as the influence of the phonological context in terms of the adjacent vowel, and word position on the /r/ vs. /l/ contrast. The training was provided in a classroom with the aid of a video-cassette recorder. The audiovisual groups saw and heard a video of Americans producing /r/ and /l/ whereas the audio-only groups only listened to the recordings. Participants marked the response on an answer sheet. Four seconds after the presentation of the stimulus, the correct word appeared on the television screen and the stimulus was repeated. Perception was assessed with a task similar to the two-alternative forced-choice training but without feedback. Production was assessed through the reading of a sub-set of 100 words from the perception test stimuli set.

The perception results indicated that all groups improved significantly with training but a greater improvement was found for the audiovisual groups. Hardison claimed that the visual modality provides information that can contribute to the formation of the new phonetic categories. Also, the Japanese participants experienced more difficulty when the adjacent vowel was /u/ and the least difficulty when the adjacent vowel was /i/ or /e/, whereas the Koreans had more difficulty with singletons and clusters with /i/. The production results were in line with previously reported studies in that improvement was found without specific training on production. The audiovisual groups improved more than the auditory groups and /r/ received higher scores than /l/. For Japanese speakers, regarding context and word position, initial clusters and contexts with /u/ and /o/ were found to be more difficult. Hardison (2005) also found (1) greater improvement for the group trained with the audiovisual modality rather than the audio-only group, and (2) effects of adjacent vowels training Korean and Japanese speakers on disyllabic words beginning with /p/, /f/, /ɹ/, /l/, and /s, t, k/ combined with high, low, and rounded vowels.

Hazan and colleagues (2005) introduced technology and individualization with the visual training modality carried out on a computer using a computerized talking head named Baldi (see Massaro, 1998). Figure 3.1 shows Baldi. The authors investigated whether participants could be successfully trained on the use of visual cues and compared audiovisual and auditory training on the /v/ vs. /b/ vs. /p/ labial/labiodental and voicing contrast and on the /l/ vs. /r/ contrast. The training programs consisted of ten sessions each. Another innovation in Hazan and colleagues' study was a greater number of participants than in previous studies – 39 Japanese speakers for the /v/ vs. /b/ vs. /p/ contrast, and 62 Japanese speakers for the /l/ vs. /r/ contrast. The authors found that learners can be trained on the use of visual cues and, in line with Hardison's results, audiovisual training was more effective than auditory training. Moreover, audiovisual training was more effective for improving perception and production even for visually less-salient contrasts.

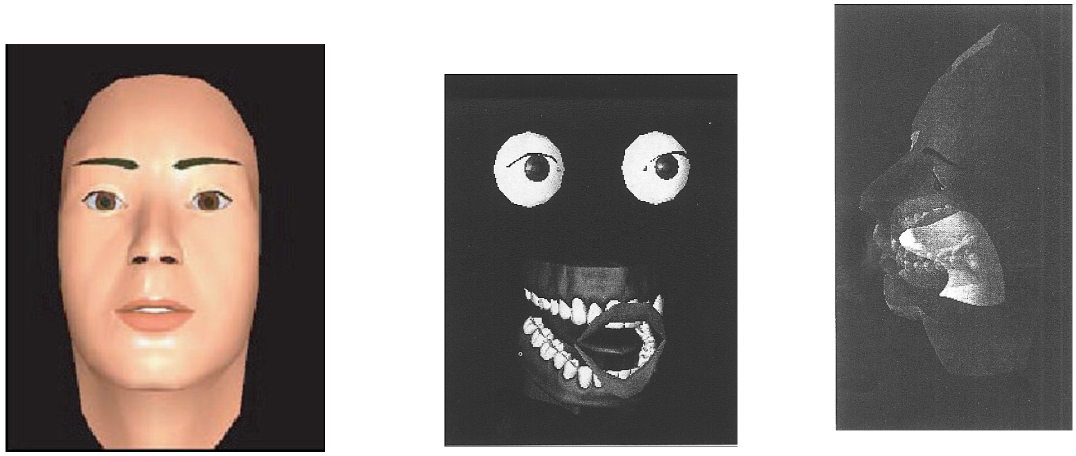


Figure 3.1 – The talking head named Baldi

Another line of research on perceptual training deals with the manipulation of acoustic cues. Iverson and colleagues (2005), for instance, used cue manipulation and introduced three conditions for training: (1) all enhancement – enhancing the contrasts by manipulation of the third formant; (2) fading technique – enhancing the contrast in the first trials and gradually minimizing the contrast to natural levels; (3) secondary cues – manipulating the second formant. Sixty-two Japanese speakers were randomly assigned to the four training conditions – one natural and three with cue manipulation – and undertook training on the identification of /r/ and /l/ during two to three weeks. The results were positive for all conditions of manipulation as well as for natural tokens in the high variability approach.

Another study using cue manipulation in the stimuli for training was carried out by Pruitt and colleagues (2006). The participants were American English speakers and Japanese speakers, all with no knowledge of the target language of the training –

Hindi. The object of the training was a place contrast – dental stop vs. retroflex stop. The manipulation consisted of four levels of truncation of the vowel in the CV syllables comprising the stimuli. The tokens were produced by two male native Hindi speakers in four of the five voicing/aspiration contexts with three different vowels /a/, /e/ and /o/, in CV syllables. Even though American English has the target sounds allophonically, the sounds contrast in Hindi but not in English or Japanese. Twenty native speakers of American English, 20 native speakers of Japanese, and 10 native speakers of Hindi were tested. Prior to training, participants were briefly instructed on the articulation of the target sounds.

Initially, Japanese speakers were better in the identification of the contrast than Americans, showing that phonemic contrastive experience with a place-of-articulation contrast similar to the Hindi dental-retroflex contrast, although not exactly the same, leads to better performance. Americans have more difficulty irrespective of having the contrasts in an allophonic status.

The training consisted of twelve sessions of ten listening blocks and ten mini-tests in each training session. The length of each session varied from 30 – 50 minutes. A listening block included fifty presentations of the tokens selected by the participant. The first session had only one talker and additional talkers were introduced as previous talkers had been mastered. The results showed reliable differences in trainee's performance according to the vowel context, voicing/aspiration context, and the talker both before and after training. Truncation of the vowel portion of CV syllables increased the discriminability of the consonants and accelerated progress in training, presumably by isolating the important acoustic cues. Training with truncated stimuli alone did not improve posttest performance with full-length unaltered stimuli any more than full-syllable training. Finally, interactive self-paced training that permitted some selection of materials appeared to produce more learning than traditional trial-oriented training methods.

The pretest-posttest results for Japanese participants on the training items were 60%–83%, a gain of 23 percentage points, and for Americans it was 54%–72%, a gain of 18 percentage points. A positive transfer was found to an untrained vowel context and to all three nontrained voicing/aspiration contexts. The persistent outperformance of Japanese participants over Americans indicated that although new phoneme contrasts can be learned, some native language influences are not easily overcome.

Concerned with the limited impact that computer-based perceptual training studies had had on pedagogy until then, Wang and Munro (2004) carried out a study where participants had "some control over lesson content" and could pose their own rhythm (p. 539). Sixteen Mandarin and Cantonese speakers were trained on three English vowel contrasts during two months. The stimuli consisted of synthetic and natural instances of monosyllables and disyllables containing /i, ɪ, ʊ, u, ɛ, æ/. Perception was assessed through a forced-choice identification test. The training task was identical to pre- and posttests except for providing immediate feedback. Participants could control their schedules and choose when they wanted to go to the lab and take the training tasks. The usual frequency of visits to the lab was two to three times a week. Each of the visits to the lab took around one hour and consisted of 24 six-minute blocks. Participants could choose the number of blocks they would complete and when they would repeat blocks or move to another. Fading blocks and variability were gradually added by the researchers. Results revealed that there was a substantial improvement from pre- to posttest and a slight drop in accuracy from posttest to the three-month retention test.

Nobre-Oliveira (2007) was the first study on perceptual training effects carried out with Brazilian learners of English. The author used synthetic stimuli and combined identification and discrimination tasks to teach six English vowels - /i/, /ɪ/, /ɛ/, /æ/, /ʊ/ and /u/. One of the greatest differences between Wang and Munro's and Nobre-Oliveira's study was that the latter investigated transfer to production. The three-week training program was designed having undergraduate English majors in mind, which allowed for the use of phonetic transcription, take-home computerized tasks, and in-class tasks with auditory stimuli and written responses on paper and immediate feedback. Two groups of learners were trained. Fourteen participants were trained with synthesized stimuli and fifteen participants were trained with natural stimuli. Perception was assessed by an identification task where the stimuli were the target vowels in CVC words, and C was always voiceless. Production was assessed by a reading task containing words and sentences. A tendency for a greater improvement was found for the group trained with synthesized stimuli, even though the tests contained only natural stimuli. Thus, transfer to natural stimuli was found. There was improvement in the perception of all vowels and in the production of the pair /i/-/ɪ/. Retention of improvement was found one month after training.

Callan and colleagues (2003) carried out a study showing that it was not only through performance that improvement in training could be assessed. Modification in areas of brain activation could also indicate whether training was effective. Functional brain imaging (fMRI) sections were used to show that training program could induce neural plasticity. The authors investigated effects of a one-month training on the /r/ vs. /l/ contrast with nine Japanese speakers by comparing before-after training brain images of the /r/ vs. /l/ contrast with images of 'easy' (/b/ vs. /g/) and 'difficult' (/b/ vs. /v/) contrasts. The training task was the same used in Bradlow et al. (1997). The same behavioral performance task of pre- and posttests was conducted inside the scanner before and after training. Behavioral results showed an improvement from 62% to 84% of production accuracy. Concerning brain imaging, the results indicated that acquisition of auditory-articulatory mappings allowed perception to be "made in reference to potential action" (Callan et al., 2003). However, brain images of /r/ vs. /l/ after training did not resemble images of /b/ vs. /g/ (easy contrast).

3.4 The high variability approach

In the nineties, Pisoni and colleagues carried out a set of studies testing effects of identification training with immediate feedback on the /r/ vs. /l/ contrast with

Japanese speakers. The studies tested the effect of variations in training and generalization to domains not tested.

The first of these studies (Logan, Lively & Pisoni, 1991) was carried out with six Japanese speakers. The training program consisted of fifteen sessions of 272 trials each, and the number of minimal pairs was 68. Each session took approximately 40 minutes and the whole training program lasted three weeks. The greatest innovation of this study was the introduction of various talkers in the input recording, more precisely, six. The inclusion of various talkers in the training program has received several names – high-variability approach, high-variability training paradigm, high-variability training technique, and high-variability identification training procedure are some examples. It aimed at preventing the participants from relying specific vocal characteristics of the talkers, rather than on the target sounds. The results of the posttests indicated improvement in perception, transfer to novel words, and transfer to new talkers.

Following the same method, Lively, Logan and Pisoni (1993) tested the different effects of training with (1) one talker and various phonological contexts and (2) five talkers and the phonological contexts which were considered difficult. The results showed that the introduction of easy contexts is not necessary and that difficult contexts and multiple talkers are enough to obtain great improvement in perception.

Using the same methodology and applying the high-variability approach, Lively and colleagues (1994) had nineteen Japanese speakers as participants and focused on three- and six-month retention of improvement after training. The results showed immediate improvement in perception of 16%, a reduction of improvement in three months maintaining 8%, and a higher reduction of improvement after six months with a retention of 4.5%. Thus, improvement was retained, but gradually reduced. The authors consider that one explanation for the reduction might be the lack of use or the lack attention to the contrast trained.

Bradlow and colleagues (1997) carried out the fourth study following the high-variability approach and using the methodology of Logan et al. (1991). The focus of the study was on transfer of improvement to the domain of speech production. The training consisted of forty-five sessions and the number of talkers was five. The participants were eleven Japanese speakers. Production was assessed through a word-reading task and an imitation task containing 55 English /r/-/l/ minimal pairs. The results showed improvement in perception with transfer to novel words and new talkers and generalization to production with 67.5% of accuracy in the pretest and 73% in the posttest. Due to the marked presence of individual differences in the results of the pretest, the authors used measures of "proportion of room for improvement, which considered the amount of improvement that could actually take place based on each participant's starting point (p. 2305). When dealing with percentages, the measure of the proportion of room for improvement considered in the studies reviewed as well as in the present study, is defined by posttest accuracy minus pretest accuracy divided by 100 minus pretest accuracy [(posttest – pretest) / (100 – pretest)].

As a follow-up to Bradlow et al. (1997), Bradlow and colleagues (1999) investigated long-term retention of improvement in the domain of speech perception and production. Eleven Japanese speakers were trained on the /r/ vs. /l/ contrast following exactly the same procedures of data-gathering and training previously used in Bradlow et al. (1997). Perception improved significantly from 65% in the pretest to 81% in the posttest and reduced to 78% in the three-month retention test; however, this reduction was not statistically significant. Concerning production, the results from three types of judge-based evaluation showed improvement from the pre-test to the posttest, and then to the retention test.

3.5 More on transfer to production

Prior to Bradlow and colleagues (1999), Rochet (1995) had tested transfer of improvement in perception to production. Twelve Mandarin speakers were trained on the contrast between French /pu/ vs. /bu/. The identification training program consisted of six sessions of thirty minutes, and the whole program lasted three hours. Each session contained seven blocks of synthetic stimuli. The greatest changes in the training format were (1) the addition of a requirement of a minimum of 95% of accuracy in a block to advance to a following block, and (2) the introduction of a fading technique, which was developed by manipulating the VOT values of /p/ and /b/ and the mode of presentation. These changes were implemented to allow participants to gradually learn the distinction. In order to advance to a following block, the participant had to show s/he had mastered the contrast trained. These changes were implemented to allow participants to gradually learn the distinction by not advancing to a following block without mastering the contrast trained.

Perception was assessed by an identification perceptual task with synthesized stimuli and an imitation task with natural stimuli, which assessed production as well. The results indicated improvement in the perception of the trained contrast and transfer of improvement to perception of (1) synthesized CV syllables with an initial bilabial, but followed by /i/ and /a/; (2) synthesized CV syllables with initial dental and velar stops; and (3) voiceless natural stimuli in word-initial position. However, no transfer was found for perception of intervocalic voiced and voiceless stops. Production in the imitation task was auditorily and acoustically analyzed. The results revealed transfer of improvement in perception to production of voiceless stops (statistically significant) voiced stops (close to significance).

Trapp and Bohn (2000) also tested transfer of improvement in perception to production. Nine Danish teenagers were trained on the English final /s/ vs. /z/ contrast. Perception was assessed by a two-alternative forced choice test and production was assessed by a sentence reading task consisting of two carrier sentences with the target structure embedded – (1) I say the word (*bus* or *buzz*) again, and (2) I say the word (*bus* or *buzz*) to you. The identification training program consisted of four sessions and the stimuli were recorded by eight talkers from three different nationalities – British, American, and Finnish. There were 192 trials in the training of four minimal pairs in each thirty-minute session. The training was spread through four weeks. There was a 14% improvement in perception of the final /s/ vs.

/z/ and transfer to perception of the initial /s/ vs. /z/ contrast, and generalization to unfamiliar talkers. No transfer to perception of words ending in /f/ and /v/ or to production of the target sounds was revealed. According to Bohn (personal communication, 2007), the level of commitment of teenagers with the training program might not have been as high as in the studies with adult participants, and this may partially justify the lack of transfer to production.

Lambacher and colleagues (2005) investigated effects of a six-week identification perceptual training on perception and production of mid and low American English vowels (/æ/, /ɑ/, /ʌ/, /ɔ/, /ɨ/). Thirty-four Japanese speakers participated in the perception experiment and a subset of twenty participants took part in the production experiment as well. The perception pre- and posttest consisted of a five alternative forced-choice (5AFC) task with 150 CVC tokens presented aurally through headphones and answers marked on an answer sheet. The combinations of previous and following consonants resulted in thirty different stimuli for each of the five vowels promoting the necessary stimulus variability suggested by Logan and colleagues (1991). Production was assessed through the reading of twenty minimal pairs (CVC) containing the five vowels. The training consisted of the identification of 75 CVC tokens (fifteen phonetic contexts for each of the five vowels), and immediate feedback was provided through headphones five seconds after the stimulus was presented, so that participants had time to respond. The six sessions of the training program were administered on a weekly basis and each session lasted about 20 minutes. Perception improved from 54% to 70% after training. Production was evaluated aurally by judges and acoustically by the researchers. Results indicated that production improved considerably without any explicit instruction on vowel articulation.

3.6 Conclusion

The positive transfer of perceptual training to the production domain suggests a relationship between speech perception and production which is consistent with both the motor theory (e.g., Liberman, Cooper, Shankweiler & Studdert-Kennedy, 1967) and the direct realist approach (e.g., Best, 1995; Fowler, 1986). The former claims that speech is perceived in terms of their articulatory gestures and the latter that the articulatory gestures are perceived through the structure they convey to the acoustic medium. Moreover, since an increase in improvement in production was found in follow-up tests, it seems that perception of one's own production enables monitoring and consequently gradual improvement after the training phase.

However, as shown in Bradlow et al. (1997), only a small correlation was found between degrees of perception and production improvement, suggesting the importance of individual differences and that "learning in the perceptual domain is not a necessary or sufficient condition for learning in the production domain" (p. 2307). Bradlow and colleagues concluded that since without explicit instruction on production, there was transfer of learning from perception to production "there is a unified, common mental representation that underlies both speech perception and speech production" (p. 308).

The SLM would explain learning in production through perceptual training as a reorganization of the auditory-acoustic phonetic space, whereas the PAM-L2 would suggest that by becoming familiar with the gestural constellations of non-native phonemes, thus with the non-native contrasts, the learner would learn how to produce the phoneme.

Reviewing the most influential studies on effects of perceptual training, Ellis (2005) concluded that providing learners with phonemes in natural words spoken by multiple talkers and immediate feedback on the identification of these words in an adaptive training fashion leads to rapid learning. The effectiveness of this type of training is due to the formation of a trace originated from the attended details of the perceptual event and its storage in long-term memory (Hardison, 2004, 2005).

CHAPTER 4

L2 ACQUISITION OF WORD-INITIAL /s/-CLUSTERS

4.1 Introduction

The main goal of the present study was to obtain a better understanding of how and to what extent perceptual training can help learners improve their speech production on both the segmental and suprasegmental levels. Word-initial /s/-clusters were selected as the object of the training program because Brazilians have problems producing /sC(C)/ on both levels – voicing of the /s/ on the segmental level and prothesis on the suprasegmental level.

Consonant clusters are difficult in L1 acquisition and /s/-clusters are the latest clusters to be acquired in English (e.g., Yildiz, 2005; McLeod, Sturt & Bleile, 2003). Also, according to the hierarchies presented in McLeod, Sturt and Bleile (2003), English speaking children acquire three-member clusters after two-member clusters. Studies reviewed by McLeod, Sturt and Bleile show the following order of acquisition: (1) /st/ and /sp/ are the first /s/-clusters to be acquired around the age of three; (2) /sn/ and /sl/ are present in the inventory of children around three years and three months; (3) /sm/ and /sk/ are acquired around the age of four; (4) /sCC/ clusters appear on the phonological inventory of children over six years.

The acquisition of /s/-clusters by learners of English as an L2 is even more difficult than it is in L1. BP learners of English tend to turn word-initial /sC(C)/ into the BP permitted initial sequence /VsC(C)/ probably because adults' cross-language speech perception is influenced by L1 phonotactics[5] (Flege, 1989; Hallé, Segui, Fraunflender, & Meunier, 1998; Sebastián-Gallés, 2005). BP does not permit initial or final /s/ consonantal clusters whereas English permits both initial and final /s/ clusters.

Also, transfer of the BP process of voicing assimilation[6] to the following sound, which turns /s/+sonorant sequences into /z/+sonorant, is common, and nonnative perception is thought to be influenced by L1 coarticulatory patterns (Beddor, Harnsberger, & Lindemann, 2002). Finally, nonnative perception is influenced by allophonic or other phonetic variations (Harnsberger, 2000, 2001) and thus palatalization may occur[7]. In this case, the cluster may be subjected to the processes of voicing, palatalization and epenthesis.

Many L2 learners fail to acquire this structure even after years of instruction and/or experience with the target language. In this chapter, I review some studies that have dealt with the acquisition of word-initial /s/-clusters by adult L2 learners, mainly Brazilians learners of English.

---

[5] For a comparison of English and Brazilian Portuguese phonotactics, see Souza (1998).

[6] For instance: the /s/ at the end of *casas* – ‘houses’ – in *casas amarelas* – ‘yellow houses’ – is pronounced as [z] because the following sound is voiced; whereas, the [s] at the end of *casas* in *casas pretas* – ‘black houses’ – is pronounced as /s/ because the following sound is voiceless.

[7] In some Brazilian Portuguese dialects, syllable-final [s] and [z] are palatalized; and, therefore, pronounced as [ʃ] and [ʒ] respectively.

4.2 Acquisition of word-initial /s/-clusters by non-native speakers

In Brazil, several have been conducted on the production of word-initial /s/-clusters (e.g., Rebello, 1997; Cornelian, 2003; Bonilha & Vinhas, 2005; Rauber, 2002, 2006; Rebello & Baptista, 2006). These studies found that the /s/ in /s/+stop clusters is frequently epenthesized and the /s/ in /s/+sonorant clusters is often epenthesized and/or voiced. In Brazilian Portuguese (BP), these processes are found in loanwords, as for instance, *stress* (/s/+stop) pronounced and written with epenthesis – 'estresse' [istrɛsɪ], and *slogan* (/s/-sonorant) pronounced with an epenthesized and voiced /s/ – [ɪzlogã]. Depending on idiolect, palatalization of /s/ is frequent; so that, *stress* may be pronounced as [ɪʃtrɛsɪ] and *slogan* as [ɪʒlogã].

One of the first studies investigating the acquisition of word-initial /s/-clusters by second language learners was carried out by Carlisle (1991). The participants of Carlisle's (1991, 1992, 1997, 1998, 2006) studies were Spanish learners of English. Carlisle found that prothesis was a common syllable simplification strategy adopted by Spanish speakers when aiming at the production of /s/-clusters. The author also found that clusters in violation of the sonority sequencing principle[8] (/s/+plosive)

[8] Following the Sonority Sequencing Principle (SSP), Roca (1994), among others, states that "the sonority profile of the syllable must slope outwards from the peak" (p.153). Words such *skin* and *tiks* are possible syllables in English, but they are in violation of the SSP since /s/ is more sonorant than /k/. Clements (1990) states that clusters conforming to the SSP are the most frequent; however, not the only possibilities, and that violations to the SSP happen in syllable boundaries because in the

were more frequently mispronounced than clusters not in violation (/s/+sonorant). The procedure adopted in the data-gathering was the recording of topically unrelated sentences containing the target structure with samples of different preceding phonological contexts. Carlisle (1997) also compared the production of /sC/ and /sCC/ in order to investigate markedness relations in terms of cluster length. Overall, his findings revealed that consonants in the preceding environment triggered vowel epenthesis more frequently than vowels did, and that three-member /s/-clusters (/sCC/) were more susceptible to modification than two-member /s/-clusters (/sC/).

Rebello (1997) replicated Carlisle's studies with Brazilian learners of English and found that, besides producing prothesis, Brazilians would transfer voicing to the production of word-initial /s/-clusters. This additional error was apparent cause of a higher frequency of errors in the production of /s/+sonorant than in the production of the illegal /s/+plosive. Six Brazilians learners of English were tested in the production of /sp, st, sk, sm, sn, sl, spr, str, skr, spl, skw/ in the phonological context of vowels, consonants and silence. Silence was found to be the context where prothesis was most frequent, followed by vowels and then consonants. The length of the cluster did not seem to play an important role concerning prothesis, even though it showed a tendency contrary to the results of Carlisle (1997) and those

---

underlying representation, the boundaries may be extrassyllabic and an epenthetic vowel may be represented.

of Abrahamsson (1997, 1999), with two-member clusters being slightly more susceptible to prothesis than three-member clusters.

The data from Rebello (1997) was reanalyzed in Rebello and Baptista (2006). The authors divided the preceding environments tested into four categories – sentence initial, pause, vowel, and consonant, whereas Rebello had not considered the occurrence of pauses. In the comparison of four types of environment, a significantly greater number of errors were found after a pause than after a non-pause environment. The authors suggest that the highest error rate in the context of a pause indicates that fluency difficulties may lead learners to "fall back on native-language syllable structure" (p.149). Also, Rebello and Baptista argue that it is likely that Carlisle found more errors in the context of consonants than vowels because he did not control for vowel tenseness as did Rebello and Baptista by selecting only tense vowels. They explain that an unstressed reduced vowel (e.g., the start) is a likely candidate for resyllabification[9] and the same is not true for a stressed vowel (e.g., low start).

In order to verify the inconsistencies between Carlisle's and Rebello's findings, Rauber (2002) investigated the production of both Spanish and Portuguese speakers who were learners of English, using the same corpus and method for both native language groups. Nine Argentinean and ten Brazilian undergraduate students of *Letras* participated in the study. Rauber's results corroborated both Carlisle's and Rebello's studies, showing that difficulty according to cluster type depended on the learner's L1, with /s/+plosive being the most difficult cluster for Spanish speakers

[9] Therefore, no epenthetic vowel is inserted.

and /s/+sonorant being the most difficult one for Brazilian Portuguese speakers, even though the difference was not statistically significant for the Brazilian group. Concerning context difficulty, Rauber's study found a different order of difficulty for Brazilians, with vowels being more problematic than consonants and then silence. Concerning cluster length, three-member clusters were more difficult for both Spanish and Portuguese speakers.

Cornelian (2003) carried out a partial replication of Rebello (1997) and Rauber (2002). Twenty Brazilian learners of English recorded a list of sentences containing word-initial /s/-clusters preceded by vowels and consonants. The aim of the study was to investigate the inconsistencies between Rebello's and Rauber's studies. Length of cluster did not seem to be an important factor concerning difficulty, as in Rebello and, /s/+sonorant clusters were more frequently modified than /s/+plosive sequences. Vowels were shown to cause more prothesis than consonants and an additional finding was that voiced phonological contexts triggered more mispronunciations than their voiceless counterparts.

4.3 The relationship between perception and production of word-initial /sC(C)/

The relationship between perception and production of /sC(C)/ in BP/English interphonology has only been investigated by Silveira (2002). Nine Brazilians, aged between 18 and 39 years old, were recorded orally translating fourteen sentences from Portuguese into English; the translations required the presence of word-initial

/s/-clusters. Perception was assessed through a discrimination test where the stimuli consisted of /VsC(C)/ and /sC(C)/ sequences. Younger participants did better on the perception test than older participants with scores varying from 11 to 100% accuracy. Concerning production, three-member clusters were easier to produce than two-member clusters and /s/+sonorant sequences were more difficult than /s/+plosive sequences. The data in the study also showed a positive correlation between perception and production considering cluster type (except for /skr/); that is, the clusters which were more accurately perceived were the clusters which were more accurately produced.

4.4 Perceptual training on /sC/

Bettoni-Techio and Koerich (2008) was the first study investigating effects of perceptual training on the pronunciation of /s/-clusters in BP/English interphonology. Perception was assessed through an identification test containing all stimuli used in the training plus phrases containing untrained /s/-clusters and an unfamiliar talker. Production was assessed through the reading of the phrases used in the perception test. The contrasts trained were [sC-isC, sC-izC, sC-zC] and the /s/-clusters trained were [sp, st, sl, sm]; therefore, there were actually eight minimal pairs [sp-isp, st–ist, sl–isl, sl-zl, sl-izl, sm-ism, sm-zm, sm-izm]. For each trained /s/-cluster, there were two words: [st] – ‘stone’ and ‘stop’; [sp] – ‘sport’ and ‘speak’; [sl] – ‘slow’ and ‘slap’; [sm] – ‘smile’ and ‘small’. For each word, there were four preceding contexts (vowel, voiceless consonant, voiced consonant, and silence).

The training consisted of two-alternative-forced-choice (2AFC) identification trials with immediate feedback and replay allowed before hitting the decision key. The stimuli were phrases produced by two talkers (T3 and T1). Recordings from one of the talkers was used in the pretest. There were six sessions with numbers of blocks varying from one to twenty-four. The number of trials in each block varied from sixteen to sixty-four. Clusters, contrasts, contexts, and number of talkers were presented in increasing difficulty in the first three sessions (/s/-stop before /s/-sonorant clusters; silence before consonant before vowel; epenthesis before voicing; one talker alone before two talkers). The participant was allowed to advance to the following block only after having obtained a 93% accuracy in the first three sessions and after a 91% accuracy in the other sessions (similar to Rochet, 1995). This difference was due to the different number of trials in the blocks across sessions. At the end of each session, the participant had an imitation block featuring some of the phrases included in the training. The imitation block was included in an attempt to trigger the participant’s awareness of the relationship between perception and production. In the fourth session, contexts were presented in randomized order. In the fifth session, contexts as well as contrasts were presented in randomized order. Finally, in the sixth session, clusters, contrasts, and contexts were randomized.

This case-study resulted in (1) a significant improvement in the perception of trained and untrained clusters, and of familiar and unfamiliar talkers in the posttest (from 74.4 to 84%), and (2) a slight, but also significant, improvement from posttest to retention after five months (from 84 to 86.3%). Concerning production, it was found a strong significant improvement was found from pretest to posttest (from 2.2 to 42%), and from posttest to a five-month retention test (from 42 to 69%). It showed that improvement was not only retained but was also augmented. It is reasoned that this happened because the participant might have started paying attention to the contrastive cues when monitoring their own speech.

4.5 Conclusion

The sequence /sC(C)/ comprises a complex structure, and; thus, may be difficult to be acquired by both L1 and L2 learners (Yildiz, 2005). Research on production of word-initial /s/-clusters by Brazilian learners of English (Rebello, 1997; Rauber, 2002; Silveira, 2002; Cornelian, 2003; Rebello & Baptista, 2006; Rauber, 2006) has shown that (1) the fact that Brazilian Portuguese phonotactics do not allow word-initial /s/-clusters causes learners to turn /sC(C)/ into /VsC(C)/. (2) Also, the Brazilian Portuguese process of voicing assimilation to the following sound tends to be transferred to the L2 causing learners to produce [z]+sonorant instead of [s]+sonorant.

Different studies have provided different hierarchies of difficulty in production of word-initial /sC(C)/. Table 4.1 displays the hierarchies of difficulty concerning preceding phonological environment and cluster type for BP learners.

Table 4.1 – Hierarchies of difficulty of environment and cluster type from the easiest to the most difficult.

	Silveira (2002)	**Rauber (2002, 2006)**	**Cornelian (2003)**	**Rebello & Baptista (2006)**	**Bettoni-Techio & Koerich (2008)**
Cluster type	str < sk < skr < spr < sl < st < sp < sn	/s/+stop < /s/+stop+/L/ < /sl/ < /sN/	/s/+stop < /sl/ < /sN/	spr, spl, str, skw, skr < st, sk, sp < sm, sn, sl	sn < st < sk, skr < sp < sm < sl < spr
Phonological environment	-	null < C < V	C < V	C, initial < V < pause	Silence < C < V

Silveira (2002) found a positive correlation between perception and production of word-initial /s/-clusters indicating that production errors may be caused by misperception. If misperception is one of the triggers of misproduction, modifying learners' perception may have an effect on learners' production. Bettoni-Techio and Koerich (2008) showed that an identification perceptual training program can actually help learners improve their perception of word-initial /s/-clusters and generalize the improvement to unfamiliar talkers and untrained /sC/ and /sCC/. Results also revealed transfer of improvement to production of word-initial /s/-clusters and retention of improvement in perception and production after five months.

CHAPTER 5

METHOD

5.1 Objectives, research questions and hypotheses

The present study aims at investigating (a) different error rates in production and perception of /sC(C)/ according to phonological context and cluster type; (b) the relationship between perception and production of word-initial /s/-clusters in BP/English interphonology; (c) the effects of identification perceptual training on the perception and production of word-initial /s/-clusters; (d) transfer of identification perceptual training to production, untrained /s/-clusters, and to discrimination; and (e) the retention of improvement eight months after training. Based on the studies reviewed, the research questions and hypotheses are the following.

Question 1: Are the production and perception of word-initial /s/-clusters influenced by phonological context and/or cluster type?

Hypothesis 1.1: The following hierarchy of difficulty is proposed for production, from the most difficult to the easiest context: vowels > voiced consonants > voiceless consonants > silence.

Background: Cornelian (2003), Rauber (2002, 2006), Bettoni-Techio & Koerich (2008)

Hypothesis 1.2: The following hierarchy of difficulty is proposed for production, from the most difficult to the easiest cluster-type: /s/+sonorant > /s/+stop > /sC(C)/.

Background: Rebello & Baptista (2006)

Hypothesis 1.3: The following hierarchy of difficulty is proposed for perception, from the most difficult to the easiest context: vowels > voiced consonants > voiceless consonants > silence.

Background: Cornelian (2003), Rauber (2002, 2006), Bettoni-Techio & Koerich (2008) (based on the existence of a relationship between perception and production, the hierarchy found for production in these studies was proposed for perception here).

Hypothesis 1.4: The following hierarchy of difficulty is proposed for perception, from the most difficult to the easiest cluster type: /s/+sonorant > /s/+stop.

Background: Rebello & Baptista (2006) (based on the existence of a relationship between perception and production, the hierarchy found for production in this study was proposed for perception here).

Question 2: Is there a relationship between identification and discrimination of word-initial /s/-clusters in BP/English interphonology?

Hypothesis 2.1: There will be a positive correlation between identification and discrimination by participant.

Background: Bettoni-Techio (2008)

Hypothesis 2.2: The clusters which are more frequently accurately identified are the ones which are more frequently accurately discriminated.

Background: Bettoni-Techio (2008)

Hypothesis 2.3: The correlation between identification and discrimination before training will be higher than the relationship between identification and discrimination after training.

Background: Bettoni-Techio (2008)

Question 3: Is there a relationship between perception and production of word-initial /s/-clusters in BP/English interphonology?

Hypothesis 3.1: There will be a positive correlation between identification and production by participant.

Background: Silveira (2002)

Hypothesis 3.2: The clusters which are more frequently pronounced accurately are the ones which are more frequently identified accurately.

Background: Silveira (2002)

Hypothesis 3.3: The correlation between identification and production before training will be higher than the relationship between identification and production after training.

Background: Bettoni-Techio (2008)

Hypothesis 3.4: There will be a positive correlation between discrimination and production by participant.

Background: Bettoni-Techio (2008)

Hypothesis 3.5: The correlation between discrimination and production before training will be higher than the relationship between discrimination and production after training.

Background: Bettoni-Techio (2008)

Question 4: What are the effects of perceptual training on word-initial /s/-clusters?

Hypothesis 4.1: There will be improvement in the identification test from the pretest to the posttest.

Background: Jamieson & Morosan (1986), Bradlow et al (1997), Hardison (2004), Nobre-Oliveira (2007), Yeon (2004), among many others.

Hypothesis 4.2: There will be transfer of improvement (in the identification task) to the discrimination test.

Background: Bettoni-Techio (2008)

Hypothesis 4.3: There will be transfer of improvement to production, that is, there will be improvement in production from the pretest to the posttest.

Background: Rochet (1995), Bradlow et. al (1997), Hardison (2004), Hazan et. al (2005), Bettoni-Techio & Koerich (2008), among many others.

Hypothesis 4.4: There will be a greater reduction of prothesis than of voicing.

Hypothesis 4.5: Improvement in the perception and production tests for the untrained clusters will not differ from improvement for the trained clusters.

Background: Bettoni-Techio & Koerich (2008)

Hypothesis 4.6: There will be retention of improvement in perception and production after eight months.

Background: Yeon (2004), Nobre-Oliveira (2007), Bettoni-Techio & Koerich (2008)

5.2 Participants

The participants were 23 Brazilian learners of English with at least 200 hours of previous formal instruction in English. Fifteen participants were assigned to the experimental group and eight were assigned to the control group. In the experimental group, six participants were adult males with ages ranging from 16 to 31 and seven were adult females with ages ranging from 20 to 55. The two remaining participants were pre-adolescent girls with ages 9 and 11 – P1 and P10 respectively. Details from the participants' profiles are displayed in Table 5.1. The pre-adolescents were grouped with the adults because it was observed that they differed between them in terms of performance in a way similar to the adult participants, and they improved as much as the adults as well.

5.3 Data-gathering material and tasks

As detailed below, seven instruments were used for data gathering and analysis: one questionnaire, four production tests, and two perception tests. Also, a training task was developed.

5.3.1 Background Questionnaire

The background questionnaire (Appendix A) aimed at assessing biographical information which was thought to be of possible influence on the results obtained in the study. Among the data gathered in the questionnaire were age, sex, amount of exposure to English, and knowledge of other languages. The information obtained is displayed in Table 5.1.

Table 5.1 – Profiles of the participants

	SEX	AGE	ABROAD	LANG. SCHOOL	SPEAK ENG. OUT CLASS	ENG. MUSIC TV	OTHER LANG.	ORIGIN
P1	F	9	No	6 years	yes	Yes	No	Videira - SC
P2	M	18	No	No (Letras)	yes	Yes	Spanish	Sombrio – SC
P3	M	25	No	2 years	no	Sometimes	No	Florianópolis – SC
P4*	M	26	No	Yes (Letras)	yes	Yes	No	- RS
P5	F	20	No	As a child (Letras)	yes	Yes	No	Florianópolis – SC
P6	F	50	No	As a child	no	Sometimes	No	Florianópolis – SC
P7	F	23	No	6 months (Letras)	yes	Yes	Spanish French	Santos - SP
P8	F	27	No	3 years (Letras)	yes	Yes	No	Curitiba - PR
P9	M	22	No	2 years (Letras)	no	yes	No	Arassatuba - SP
P10	F	11	No	7 years	no	Yes	No	Videira - SC
P11	M	21	No	(Letras)	yes	Yes	No	
P12	F	23	1.5 years / Vancouver	6 years (Letras)	yes	Yes	French	Maringá - PR
P13	M	23	No	(Letras)	sometimes	Yes	No	Florianópolis - SC
P14*	F	35	3 months	10 years	yes	Yes	No	Videira – SC
P15	M	16	No	7 years	sometimes	Yes	No	Videira – SC
P16C	F	18	No	3 years	no	Yes	German	Florianópolis – SC
P17C	F	12	No	3 years	no	Yes	No	Videira – SC
P18C	F	12	No	3 years	No	Yes	No	Videira – SC
P19C	F	30	1 month	8 years (Letras)	Yes	Yes	French	Videira – SC
P20C	M	31	No	4 years	No	Sometimes	German	Florianópolis – SC
P21C	F	28	No	3 years	Sometimes	Yes	No	Fraiburgo – SC
P22C	F	52	No	4 years	No	No	German	Itapiranga – SC
P23C	F	55	No	Over 10 years	Yes	Yes	Spanish	Maringá and Londrina – PR

* English teacher.
C stands for control group.

5.3.2 Reading test in Brazilian Portuguese

A reading test in BP (Appendix B) was designed in order to screen participants for dialectal and idiolectal variations (mainly, palatalization of /s/ and /z/). Participants were recorded reading a short text containing words such as *esmeralda* [ezmerawda], [eʒmerawda], [ɪzmerawda] or [ɪʒmerawda] – 'emerald'. No palatalization of the fricatives was found in the BP and in the English data, though.

5.3.3 Semi-free production test

A short interview (Appendix C) was conducted by the researcher aiming at eliciting word-initial /s/-clusters through a task which could be considered closer to daily language production than the reading task.

5.3.4 Text-reading tests

Two text-reading tests were administered aiming at eliciting production of /s/-clusters. The first text was a paragraph prepared for testing ESL/EFL learners' pronunciation (http://accent.gmu.edu/pdfs/elicitation.pdf) (Appendix D). It contains ten tokens of word-initial /s/-clusters.

The second text was *The story of Sleeping Beauty* (http://www.bbc.co.uk/education/wordsandFigures) (Appendix E), originally prepared for giving practice on word-initial /s/-clusters to native English speaking children. It contains sixteen tokens of word-initial /s/-clusters.

5.3.5 Phrase-reading test

A phrase[10]-reading test administered in Bettoni-Techio and Koerich (2008) (Appendix F) was used to assess production in controlled phonological contexts, therefore, comprising a sample more readily comparable with the perception data. The clusters included were (a) /sl/ - represented by the words ‘slow’ and ‘slap’; (b) /sm/ - represented by the words ‘small’ and ‘smiles’; (c) /sn/ - represented by the words ‘snow’and ‘snail’; (d) /sk/ - represented by the word ‘scan’; (e) /sp/ - represented by the words ‘speak’ and ‘sport’; (f) /st/ - represented by the words ‘stop’ and ‘stone’; (g) /skr/ - represented by the word ‘scream’; and (h) /spr/ - represented by the word ‘spring’. There were two words representing each cluster included in the training program (/sl/, /sm/, /sp/, and /st/) and one word representing each cluster not included in the training program. The clusters /skr/ and /spr/ were included to test generalization of training to three-member /s/-clusters derived from an untrained two-member cluster (/sk/) and a trained two-member cluster (/sp/). Four preceding phonological contexts were tested (a) a vocalic context - /aʊ/ as in ‘how smiles’; (b) a voiceless consonant - /f/ as in ‘if smiles’; (c) a voiced consonant - /v/ as in ‘move smiles’; and (d) silence as in ‘smiles’. The total number of tokens was 45 per participant.

---

[10] Phrases in the present study are defined as sequences of words. Some of these sequences are not syntactic phrases.

5.3.6 Perceptual discrimination test (AX)

An AX discrimination test (Appendix G) was developed (1) to investigate the relationship between identification and discrimination and between production and discrimination, and (2) to investigate generalization of improvement from identification to another perceptual task – discrimination. The contrasts tested were /sC-isC, sC-izC/ and /sC-zC/. The phrases included in the test were taken from the phrase-reading test where the target clusters were [st] and [sl] in the phonological contexts of [aʊ] and [v]. Participants listened to pairs of phrases (AX) and had to say whether A and X were the same or different (e.g., move slow (A), moves low (X) – different; or move slow (A), move slow (X) – the same). The stimuli were recorded by three Americans. Each trial contained input from different talkers and the tokens of each contrast appeared in A and X positions. This arrangement resulted in four repetitions of each pair (AA, AX, XA, XX). The sequence /s/+stop was tested only tested in contrast with /Vs/+stop since English /s/+stop clusters are not susceptible to voicing by assimilation. Following Kabak and Idsardi (2007), the intrastimulus interval was 1500 ms and the interstimulus interval was 2000 ms. Based on Werker and Logan (1985), the authors set these interval values with the intent of assuring perception at the phonemic rather than at the acoustic level. The number of minimal pairs tested was eight and the total number of trials was 84.

5.3.7 Perceptual identification test

The second perception test administered (Appendix H) was a two-alternative forced-choice identification test adapted from Bettoni-Techio and Koerich (2008). The contrasts tested were /sC-isC, sC-izC, sC-zC/ and the /s/-clusters tested were [st,sp, sk, sl, sm, sn]; therefore, there were twelve minimal pairs /st – ist, sp – isp, sk – isk, sl – isl, sl – zl, sl – izl, sm – ism, sm – zm, sm – izm, sn – isn, sn – zn, sn – izn/. There were four preceding contexts: a voiced consonant as in ‘move’, a voiceless consonant as in ‘if’, a vowel-like sound as in ‘how’, and silence.

The stimulus used also in the discrimination test ([st] and [sl] in the phonological contexts of [aʊ] and [v]) was produced by three Americans. The remainder of the stimuli was recorded by the only American who was not heard during training (T2). Participants listened to a single stimulus, read two phrases, and had to identify the stimulus heard with one of the phrases. The total number of tokens was 80.

5.3.8 Perceptual identification training task

The training task (Appendix I) was the same used in Bettoni-Techio and Koerich (2008). The stimuli used in the training was part of the stimuli recorded by T1 (male) and T3 (female) for the perception test. Those stimuli (four clusters) not used in the training were used to investigate generalization. The inclusion of two talkers was aimed at adding variability so that within category distinctions were reduced.

The contrasts trained were /sC-isC, sC-izC, sC-zC/ and the /s/-clusters trained were [st, sp, sl, sm]; therefore, there were eight pairs /sp–isp, st–ist, sl – isl, sl– zl, sl – izl, sm – ism, sm – zm, sm – izm/. There were two words for each trained /s/-cluster. For [sp], ‘sport’ and ‘speak’; for [st], the words were ‘stone’ and ‘stop’; for [sl], ‘slow’ and ‘slap’; and for [sm], ‘smile’ and ‘small’. For each word, there were four preceding contexts so that the phrases used during the training were those heard during the perception tests. The contexts were a vowel-like sound as in ‘how’, a voiced consonant as in ‘move’, a voiceless consonant as in ‘if’, and silence.

The training material consisted of two-alternative-forced-choice (2AFC) identification trials, as shown in Figure 5.1, with immediate feedback, as shown in Figure 5.2 and Figure 5.3, and replay allowed before hitting the decision key.

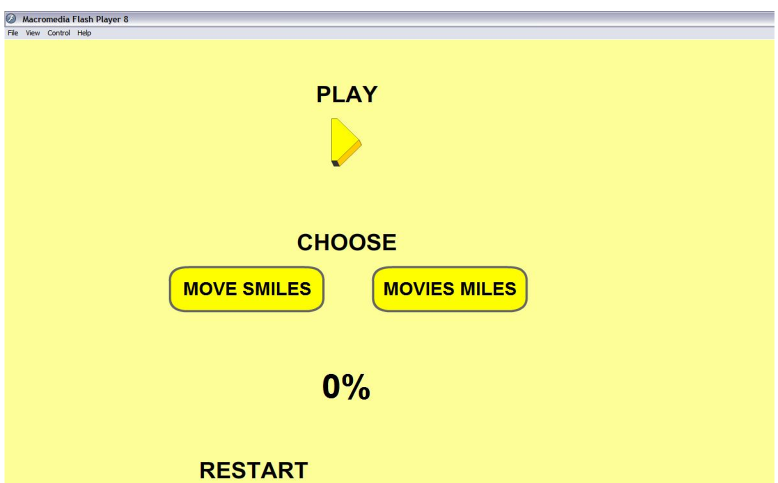


Figure 5.1 – Perceptual training program

Figure 5.2 – Immediate feedback after an error

Figure 5.3 – Immediate feedback after a correct answer

There were six sessions with numbers of blocks varying from one to twenty-four. The number of trials in each block varied from sixteen to sixty-four. The number of talkers, number and type of clusters, number and type of contrasts, and number and type of contexts were presented in increasing difficulty in the first three sessions (one talker alone before two talkers, /s/-stop before /s/-sonorant clusters; prothesis before voicing; and, silence before consonant before vowel). The hierarchy of difficulties concerning types of clusters and types of contexts were based on Rebello (1997).

The first session contained stimuli recorded by only one of the talkers. The second session contained stimuli recorded by the other talker. From the third session on, stimuli produced by both talkers were put together and presented randomly. In the fourth session, contexts were randomized for presentation. In the fifth session, contexts, as well as contrasts, were randomized. Finally, in the sixth session, clusters, contrasts, and contexts were randomized.

The participants were allowed to advance to the following block only after having obtained 93% of accuracy in the first three sessions and after 91% of accuracy in the other sessions (adapted from Rochet, 1995). The difference in the level of accuracy required was due to the different number of trials in the blocks across sessions.

At the end of each session, there was an imitation block, as shown in Figure 5.4 and Figure 5.5, featuring some of the twenty-eight phrases containing /s/-clusters used in the training. The imitation block was included with the intent of guiding participants' attention to the relationship between perception and production, since research has shown that attention guiding is an efficient strategy (e.g., Guion & Pederson, 2007). Participants listened to a phrase, imitated it, and read on the laptop screen the just-imitated phrase.

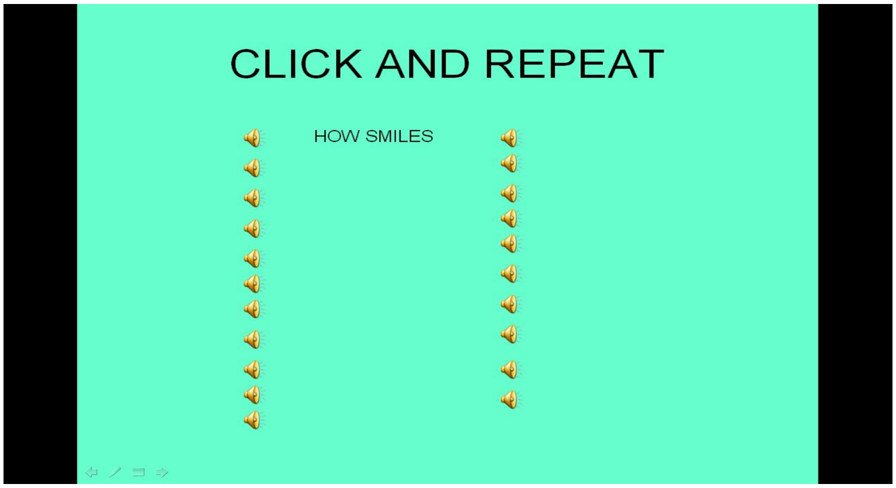


Figure 5.4 – Imitation block during administration

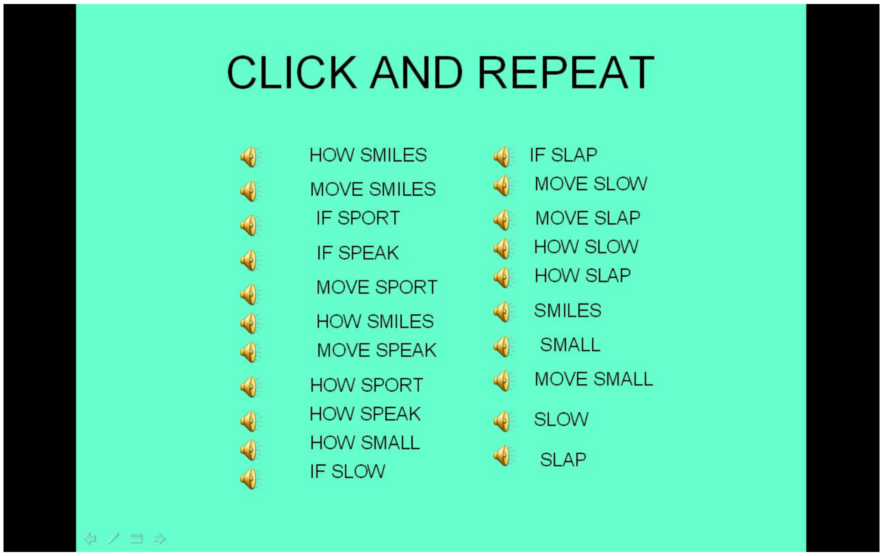


Figure 5.5 – Imitation block at the end of administration

5.4 Procedure

Participants were instructed in BP in order to assure comprehension. The study consisted of four phases: (a) pretest; (b) training; (c) posttest; and (d) retention test.

The twenty-three participants took eight tests (consisting of the block called 'pretest') in the following order: (1) a background questionnaire, (2) a reading test in BP,

(3) an interview, (4) a paragraph-reading test, (5) a story-reading test, (6) a phrase-reading test, (7) an AX discrimination test, and (7) an identification test. Short intervals were given after each test, and the sessions lasted from 45 to 60 minutes. Following that, the participants were trained on the identification of word-initial /s/-clusters. The first block of training consisted of the easiest cluster in the easiest phonological context (see Table 4.1) testing the most salient contrast (if stop vs. iffy stop). According to each participant's performance on the first block of training, the participant would be trained on the 'prothesis' contrast. A 100 % accuracy score in the first block of training determined that the participant skipped the blocks where 'prothesis' was the only pertinent contrast; however, he/she had to take the blocks which trained 'prothesis', 'voicing', and 'prothesis and voicing' contrasts altogether. This measure was taken to allow the participants to focus on their specific difficulties, individualizing the training and avoiding exhaustion by unnecessary repetition. At the same time, a minimum amount of exposure to all contrasts was assured. The total length of training varied from two to six hours over one to three weeks.

The twenty-three participants took the posttest around ten days after the pretest, that is, immediately after the training administered to the experimental group. The order of the tests was (1) the interview, (2) the paragraph-reading test, (3) the story-reading text, (4) the phrase-reading test, (5) the AX discrimination test, and (6) the identification test. Participants took from 40 to 50 minutes to complete the posttest.

The retention test was identical to the posttest and was administered around eight months later. Eight participants from the experimental group (P1, P2, P4, P5, P8, P9, P10, and P12) took the retention test. P3 and P6 were not included in the retention test because they spent around a month in Canada after the posttest and it was reasoned that there would be effects of language experience in their performance. P7 and P15 were not included because they could not be reached, and P11 and P13 did not show up for the session. Finally, P14 was not included in the posttest because she was trained a few months after the other participants, and the interval between the posttest and the retention test in her case was shorter than for the other participants. The administration of all tests and the training program was conducted by the researcher in individual meetings with the participants.

5.5 Data Analysis

Production was perceptually analyzed by the researcher, and acoustically analyzed using Praat 4.3.12 software. With the aid of spectrograms, the productions of /sC(C)/ were categorized as /sC(C)/, /VsC(C)/, /zC(C)/ or /VzC(C)/.

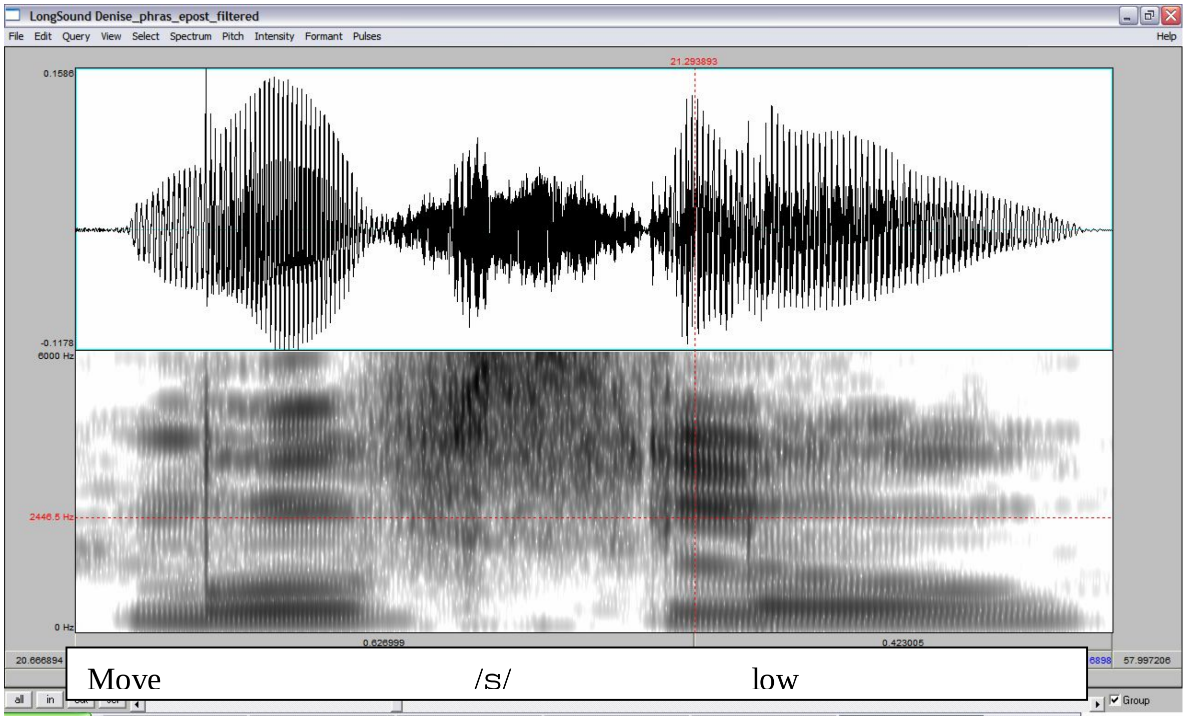


Figure 5.6 – Production of ‘move slow’ by P6 in the posttest

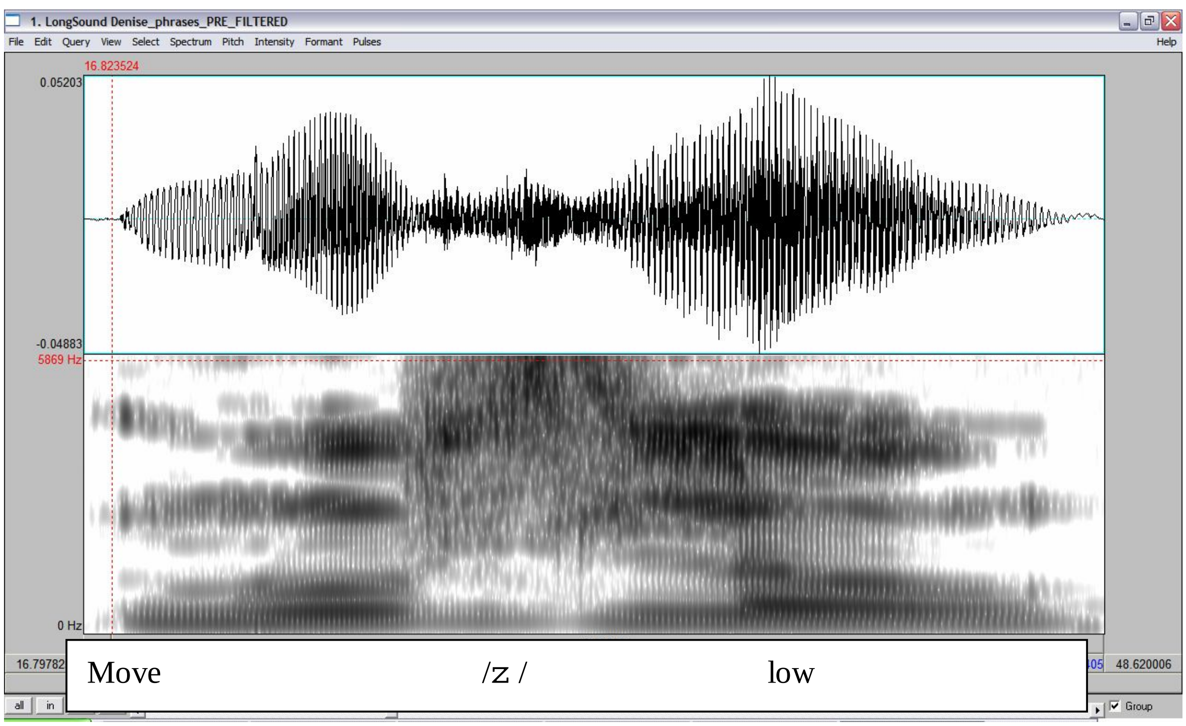


Figure 5.7 – Production of ‘move slow’ by P6 in the pre-test

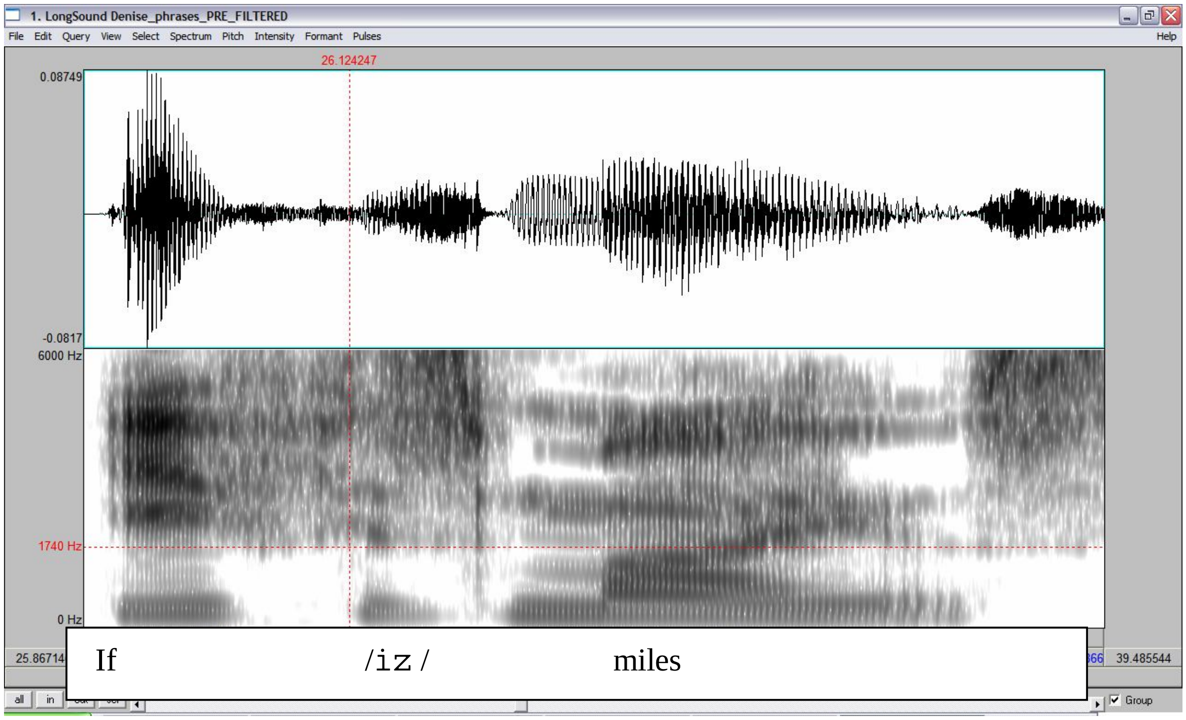


Figure 5.8 – Production of ‘if smiles’ by P6 in the pretest

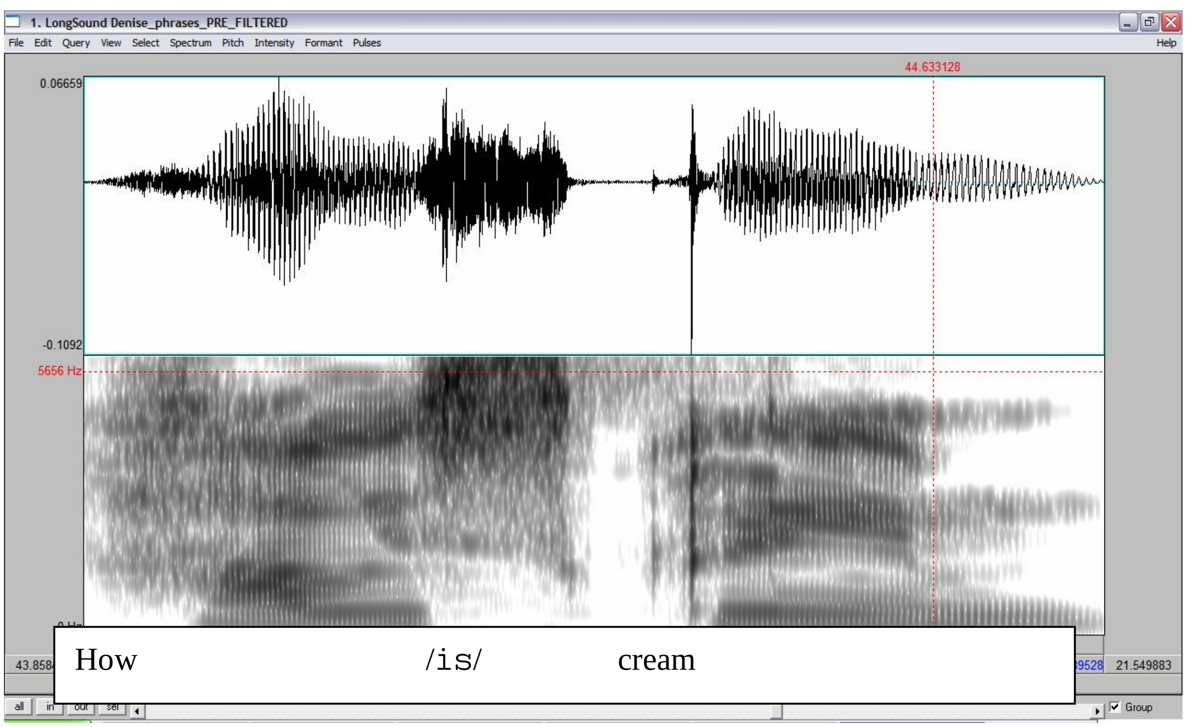


Figure 5.9 – Production of ‘how scream’ by P6 in the pretest

Perception data were analyzed according to number of correct answers in the identification and discrimination tests as well as according to each contrast - /sC-isC, sC-zC, sC-izC/.

The data received statistical treatment using the Statistical Package for Social Studies (SPSS) software in order to better investigate the proposed hypotheses. Pearson Correlation Tests and Spearman's Rank Order Correlation Tests were run on the data to investigate relationship issues. Wilcoxon Signed Ranks Tests were selected to investigate improvement. Kruskal-Wallis tests and Mann-Whitney tests were used to investigate effects of nominal variables. Besides gain scores, proportions of the room for improvement were calculated according to one of the following formulae: (posttest-pretest)/(100-pretest) – when dealing with percentages, or (posttest-pretest)/(N-pretest) – when dealing with raw scores.

CHAPTER 6

RESULTS AND DISCUSSION

This study was motivated by the observation that the production of word-initial /s/-clusters by BP learners of English is problematic and by the reasoning that mere awareness of how the structure should be articulated tends not to lead to better production, and, it was made possible by the advance of computer-assisted tools in education.

Frequently, learners claim they cannot perceive the difference between the erroneous and the accurate production of word-initial /s/-clusters (e.g., /izmail/ vs. /smail/). Perceptual training has been successfully used regarding several non-native contrasts (e.g., /θ/ vs. /ð/, as in Jamieson & Morosan, 1986; /t/ vs. /d/, as in Flege, 1989; /s/ vs. /z/, as in Trapp & Bohn, 2000; CV+alveolopalatal vs. CV+alveolopalatal+V, as in Yeon, 2004).

However, /s/-clusters have not been the object of any of the studies on perceptual training published so far. To verify issues related to perceptual training and the pronunciation of word-initial /s/-clusters, eighteen hypotheses were investigated. Twelve of these hypotheses concerned perception and production and six concerned effects of training.

6.1 Perception and production of word-initial /s/-clusters

The first question which motivated the present study concerned the perception and production of word-initial /s/-clusters in BP/English interphonology in relation to two variables previously tested in the production domain by Rauber (2002, 2006), Silveira (2002), Cornelian (2003), and Rebello and Baptista (2006), namely – phonological context and cluster type. And in the perception domain by Silveira (2002) – cluster type. The influence of phonological context has not been tested in the perception domain considering word-initial /s/-clusters.

In order to answer this question, production data of all participants in the pretest phase were analyzed. Data obtained from the interview were not included due to the lack of control over phonological context and cluster type and consequent variation among participants.

Two hypotheses were investigated concerning production and two were investigated concerning perception. The production hypotheses are discussed below followed by the perception hypotheses.

6.1.1 Production of word-initial /s/-clusters and phonological context – H1.1

Following Cornelian (2003), the first hypothesis stated that 'vowels' would trigger more errors than 'consonants', which would trigger more errors than 'silence' preceding /sC(C)/, and that 'voiced consonants' would trigger more errors than their 'voiceless counterparts'. Thus, from the most difficult to the easiest context, the following hierarchy was proposed: V > + vd C > - vd C > silence.

The mean accuracy in the production task was 65%. Thus, many errors occurred. Table 6.1 displays the rate and raw scores of accurate productions in the pretest by phonological context.

Table 6.1 – Production in the pretest by preceding phonological context

Context	**N**	**Raw Score**	**Accuracy Rate**
Silence	161	98	61%
Vowel	483	275	57%
Voiceless consonant	437	317	72%
Voiced consonant	552	372	67%
TOTAL	**1633**	**1062**	**65%**

The following hierarchy of difficulty was found concerning the effect of phonological context, from the most difficult to the easiest: vowels (57%) > silence (61%) > voiced consonant (67%) > voiceless consonants (72%). The coincidences with the hierarchy proposed in the hypothesis are that vowels actually triggered more misproductions than the other contexts and that voiced consonants caused more errors than voiceless consonants. Silence, on the other had, was found to be much more problematic than expected. In order to investigate whether the differences found were significant, statistical tests were run on the data of the twenty-three participants.

A Kruskall-Wallis Test yielded a non-significant result for context effect, x^2 = 4.066, p = .254. Against the predictions of the hypothesis, the results indicated that there was no significant effect of phonological context on the rate of mispronunciations.

6.1.2 Production of word-initial /s/-clusters and cluster type – H1.2

Hypothesis 1.2 stated that /s/+sonorant clusters would be more frequently modified than /s/+stop clusters. Also among the /s/+stop clusters, two-member clusters would be more frequently modified than three-member clusters.

Table 6.2 displays the data obtained for accurate production in the pretest by cluster type.

Table 6.2 – Results in production by cluster type

	N	**Raw Score**	**Accuracy rate**
/st/	276	244	88%
/sp/	299	244	82%
/sk/	92	68	74%
/s/+stop	**667**	**556**	**83%**
/skɾ/	92	77	84%
/spɾ/	92	79	86%
/sCC/	**184**	**156**	**85%**
/sm/	230	85	37%
/sn/	299	137	46%
/sl/	253	128	51%
/s/+sonorant	**782**	**350**	**45%**
TOTAL	**1633**	**1062**	**65%**

The results shown on the table seem to indicate that there was no effect of cluster length on production, and that /s/+sonorant clusters were more difficult to be pronounced than /s/+stop clusters. In order to verify whether the differences were significant, Mann-Whitney Tests were run on the data. The Mann-Whitney Test run on /sC/ and /sCC/ clusters confirmed that cluster length did not affect the results, Z = .111, p = .928, and the Mann-Whitney Test run on /sC/ vs. /s/+sonorant yielded a significant result, Z = 6.953, p = .000, showing that /s/+sonorant clusters were significantly more difficult to be produced than /s/+stop clusters. Thus, Hypothesis 1.2 was partially corroborated.

6.1.3 Perception of word-initial /s/-clusters and phonological context – H1.3

Based on the premise that there is a relationship between perception and production, the hierarchy of difficulty found for production in previous studies was proposed for perception, in the line of hypothesis H1.1 above: V > +vd C > -vd C > silence. Since the stimuli used in the discrimination test was limited to vowels and voiced consonants, in order to test this hypothesis, only the data obtained from the identification test were used. The results obtained in the identification test by context are displayed in Table 6.3.

Table 6.3 – Results for identification in the pretest by phonological context

Context	N	Raw Score	Accuracy Rate
Silence	138	125	90.57%
Vowel	552	435	78.80%

Voiced consonant	736	565	76.76%
Voiceless consonant	414	355	85.74%
TOTAL	**1840**	**1480**	**80.43%**

Even though the results pointed to silence and voiceless consonants as easier phonological contexts regarding perception, a Kruskal-Wallis Test failed to yield significance, $x^2 = 6.157$, $p = .104$. Hypothesis 1.3 was not confirmed, but results showed a tendency towards it.

6.1.4 Perception of word-initial /s/-clusters and cluster type – H1.4

Hypothesis 1.4 was based on a combination between the results of Rebello and Baptista (2006) and on the results of Silveira (2002) who found a tendency for correlation between perception and production concerning cluster type. The hierarchy proposed for production was proposed for perception: /s/+sonorant > /s/+stop. Table 6.4 displays the results obtained in the identification pretest by cluster type.

Table 6.4 – Identification pretest by cluster type

	IDENTIFICATION		
	N	**Raw Score**	**Accuracy rate**
/st/	138	123	89.13%
/sp/	138	118	85.50%
/sk/	138	118	85.50%
/s/+stop	**414**	**359**	**86.71%**
/sm/	414	324	78.26%
/sn/	414	328	79.22%
/sl/	598	469	78.42%
/s/+sonorant	**1426**	**1121**	**78.61%**
TOTAL	**1840**	**1480**	**80.43%**

A Mann-Whitney Test failed to yield significance, $Z = 1.859$, $p = .063$. However, there is a tendency in the direction of the hypothesis and significance ($p < .05$) was almost reached.

6.2 The relationship between identification and discrimination

The second question which motivated the present study concerned the relationship between identification and discrimination of word-initial /s/-clusters in BP/English interphonology.

As described in the method, of the six clusters tested in the identification test, only two were tested in the discrimination test, – one /s/+stop cluster and one /s/+sonorant cluster. Also, of the four phonological contexts tested in the identification test, two were tested in the discrimination test. The phonological contexts tested were the vowel in 'how' and the voiced consonant, in 'move'. These were selected because were found to be the most difficult contexts in previous studies (e.g., Bettoni-Techio & Koerich, 2008; Rauber, 2002, 2006).

The relationship between identification and discrimination was analyzed by participant. A positive correlation between the two perception tests would imply that the participants who performed better in one of the tests would perform better in the other perception test and such relationship is investigated in Hypothesis 2.1. Hypothesis 2.2 proposes that there would be a correlation between discrimination and identification considering cluster type. Also, investigating the relationship between identification and discrimination in the present study implies investigating the effects of perceptual training on this relationship. To do so, correlations were run for the results of the tests carried out in the pretest phase and in the posttest phase investigating Hypothesis 2.3 which, based on Bettoni-Techio (2008), proposed that the correlation before training would be stronger than the correlation after training.

6.2.1 Relationship between identification and discrimination – H2.1

Scores of the pretest phase of all participants were used to investigate Hypothesis 2.1. The results obtained in the identification and in the discrimination tasks by each participant are displayed in Table 6.5.

Table 6.5 – Identification and discrimination pretests

	Identification				Discrimination			
	Rank	**N**	**Score**	**%**	**Rank**	**N**	**Score**	**%**
P1	15	80	65	81.25%	15	84	57	67.86%
P2	8	80	73	91.25%	6	84	68	80.95%
P3	15	80	65	81.25%	11	84	65	77.38%
P4	18	80	53	66.25%	18	84	55	65.48%
P5	6	80	75	93.75%	11	84	65	77.38%
P6	16	80	60	75.00%	19	84	50	59.52%
P7	8	80	73	91.25%	13	84	62	73.81%
P8	6	80	75	93.75%	3	84	71	84.52%
P9	11	80	67	83.75%	14	84	61	72.62%
P10	20	80	49	61.25%	21	84	44	52.38%
P11	10	80	72	90.00%	8	84	66	78.57%

P12	1	80	79	98.75%	1	84	80	95.24%
P13	6	80	75	93.75%	8	84	66	78.57%
P14	10	80	72	90.00%	12	84	64	76.19%
P15	3	80	78	97.50%	4	84	69	82.14%
P16	17	80	59	73.75%	17	84	56	66.67%
P17	23	80	42	52.50%	23	84	37	44.05%
P18	22	80	43	53.75%	22	84	38	45.24%
P19	3	80	78	97.50%	1	84	80	95.24%
P20	20	80	49	61.25%	21	84	44	52.38%
P21	15	80	65	81.25%	11	84	65	77.38%
P22	15	80	65	81.25%	6	84	68	80.95%
P23	21	80	46	57.50%	17	84	56	66.67%
MEAN			**64**	**80.33%**			**60**	**71.79%**

Table 6.5 shows that individual differences play a very important role in the performance of the participants. The scores varied from 52.50% to 98.75% in the identification test and from 44.05% to 95.24% in the discrimination test.

Figure 6.1 illustrates the relationship between identification and discrimination

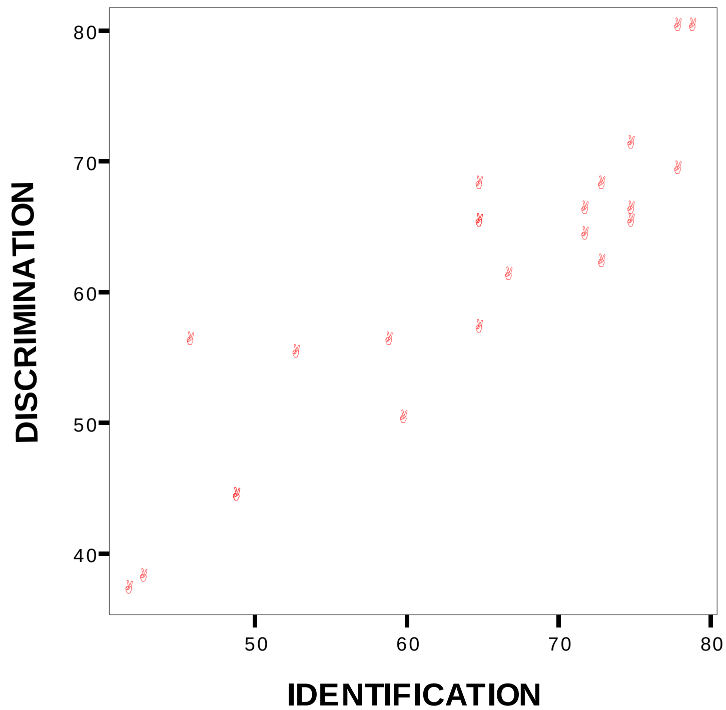


Figure 6.1 – Correlation between identification and discrimination by participant

A Pearson Correlation test yielded a significant result revealing a positive correlation between identification and discrimination, *r*(22) = .904, p = .000. A Spearman's Rank Order Correlation test, a non-parametric test used for data not normally distributed, also yielded a significant correlation, *rho*(22) = .893 p = .000. These results indicate that the ability to identify one sound structure, in this case word-initial /s/-clusters, has a close relationship with the ability to discriminate this sound or sound structure from other sounds. At identifying one sound, one may resource to discriminating that sound from others, since perception is considered to be categorial. The strong correlation between identification and discrimination found in this study implies that training participants to identify a specific sound structure may cause improvement in the discrimination of this sound structure from others and, thus, generalization can be expected.

6.2.2 Relationship between identification and discrimination by cluster type – H2.2

In the discrimination test, one exemplar of /s/+stop was tested - /st/ - and one exemplar of /s/+sonorant was tested - /sl/. Each cluster type was tested in the phonological context of a vowel and of a voiced consonant which were shown to be the most difficult contexts in previous studies (e.g., Cornelian, 2003). The results by token and cluster type for the perception tests are displayed in Table 6.6.

Table 6.6 – Perception tests by cluster type

	Identification				**Discrimination**			
	RANK	**N**	**Score**	**Rate**	**RANK**	**N**	**Score**	**Rate**
How stop		46	43	93.47%		184	155	84.24%
Move stop		46	40	86.95%		184	136	73.91%
	1	**92**	**83**	**90.22%**	**1**	**368**	**291**	**79.07%**
How slow		138	107	77.54%		460	344	74.78%
Move slow		322	242	75.15%		1104	764	69.20%
	2	**460**	**349**	**75.87%**	**2**	**1564**	**1108**	**70.84%**
MEAN		**552**	**432**	**78.26%**		**1932**	**1399**	**72.41%**

The cluster /st/ was easier to perceive in both tests, indicating a possible relationship according to cluster type. A Spearman's Rank Order Correlation Test yielded a strong, but only close to significance, correlation between identification and discrimination, *rho*= .949, p = .051. The Pearson Test was not run because the number of cases was too small. The hypothesis was, then, partially corroborated.

6.2.3 Relationship between identification and discrimination before and after training – H2.3

In order to investigate Hypothesis 2.3 only data obtained from the experimental group were used. The hypothesis aimed at verifying whether training would cause learners to rely (1) on new cues and/or (2) on old cues but to a different extent, when discriminating sounds.

Table 6.7 presents raw scores and rates obtained by each participant in the identification and discrimination tests before and after training.

Table 6.7 – Results in perception before and after training

	Identification					Discrimination				
			pretest		posttest			pretest		Posttest
	N	Score	Rate	Score	Rate	N	Score	Rate	Score	Rate
P1	80	65	81.25%	77	96.25%	84	57	67.86%	76	90.48%
P2	80	73	91.25%	79	98.75%	84	68	80.95%	76	90.48%
P3	80	65	81.25%	79	98.75%	84	65	77.38%	80	95.24%
P4	80	53	66.25%	68	85.00%	84	55	65.48%	67	79.76%
P5	80	75	93.75%	79	98.75%	84	65	77.38%	65	77.38%
P6	80	60	75.00%	68	85.00%	84	50	59.52%	63	75.00%
P7	80	73	91.25%	80	100.00%	84	62	73.81%	83	98.81%
P8	80	75	93.75%	77	96.25%	84	71	84.52%	79	94.05%

P9	80	67	83.75%	73	91.25%	84	61	72.62%	77	91.67%
P10	80	49	61.25%	67	83.75%	84	44	52.38%	51	60.71%
P11	80	72	90.00%	75	93.75%	84	66	78.57%	77	91.67%
P12	80	79	98.75%	79	98.75%	84	80	95.24%	80	95.24%
P13	80	75	93.75%	76	95.00%	84	66	78.57%	74	88.10%
P14	80	72	90.00%	76	95.00%	84	64	76.19%	72	85.71%
P15	80	78	97.50%	79	98.75%	84	69	82.14%	82	97.62%
MEAN		**69**	**85.92%**	**75**	**94.33%**		**63**	**74.84%**	**73**	**87.46%**

Pearson correlation tests yielded significant results for before and after training scores. The results obtained were *r*(14) = .891, p = .000, before training, and *r*(14) = .773, p = .001 after training. The Spearman's Rank Order Correlation test also yielded significant correlations, *rho*(14) = .880, p = .000 before training and *rho*(14) = .692, p = .004 after training.

The results obtained for H2.1, H2.2, and H2.3 indicate that (1) the ability of identifying one sound structure, in this case word-initial /s/-clusters, has a strong relationship with the ability of discriminating this sound or sound structure from other sounds; or, (2) both tests were assessing the same ability – perception of a foreign language sound – and the small difference between the scores was probably due to task design. The numbers indicate a relationship between identification and discrimination of nearly 80% before training and around 56% after training. The strong correlation between identification and discrimination found in the pretest seems to imply that training participants to identify a specific sound structure may cause improvement not only in its identification, but also in its discrimination, which was confirmed, as discussed later, through the investigation of the fourth question.

The strong relationship (80%) found before training turned into a moderate relationship (56%) after training. After training, participants, in general, were more consistent in mastering the identification test, as can be seen in Table 6.7, but had varying performances in the discrimination test. This variation may be partially responsible for the reduction in the strength of the relationship after training. The different improvement in the two tests may just suggest that there was a task effect, since learners were trained on an identification test where they had written stimuli as answer options. In the discrimination test, learners had to rely on memory and did not have written stimuli. Some participants reported getting confused with the discrimination task because they associated one of the positions with a specific sound and others reported having difficulty in maintaining the first token in memory in order to compare and contrast with the second token in each trial of the AX task. Even so, there was significant improvement from pre- to posttest in the discrimination task showing that the training was effective.

6.3 The relationship between perception and production

Regarding relationship issues, the third question sought to investigate the relationship between production and identification and between production and discrimination of word-initial /s/-clusters in BP/English interphonology. For the training task to affect the production of Brazilian speakers, identification and production have to relate. Also, the relationship between discrimination and production was tested. The relationships were examined before and after training to verify whether they would be maintained after training since it is attested that there is a tendency for reduction as learners improve in proficiency, and that learners tend to achieve better ultimate performance in production than in perception (Strange, 1995). Five hypotheses were proposed and the results of the investigation are presented and discussed below.

6.3.1 The relationship between production and identification – H3.1

Hypothesis 3.1 proposed that there would be a relationship between identification and production of word-initial /s/-clusters. This relationship is necessary for the success of perceptual training in that generalization to production is the main goal of the training program. Since the number and type of data obtained from the interview varied among participants, the data from the interview task were not included in this analysis. Table 6.8 displays the results of the identification and production pretests.

Table 6.8 – Identification pretest and reading pretest

	IDENTIFICATION				PRODUCTION			
	Rank	**N**	**Score**	**Rate**	**Rank**	**N**	**Score**	**Rate**
P1	15	80	65	81.25%	3	71	64	90.14%
P2	8	80	73	91.25%	7	71	59	83.10%
P3	15	80	65	81.25%	15	71	40	56.34%
P4	18	80	53	66.25%	19	71	32	45.07%
P5	6	80	75	93.75%	13	71	47	66.20%
P6	16	80	60	75.00%	17	71	34	47.89%
P7	8	80	73	91.25%	6	71	62	87.32%
P8	6	80	75	93.75%	11	71	53	74.65%
P9	11	80	67	83.75%	12	71	48	67.61%
P10	20	80	49	61.25%	17	71	34	47.89%

P11	10	80	72	90.00%	9	71	57	80.28%
P12	1	80	79	98.75%	6	71	62	87.32%
P13	6	80	75	93.75%	1	71	71	100.00%
P14	10	80	72	90.00%	9	71	57	80.28%
P15	3	80	78	97.50%	14	71	46	64.79%
P16	17	80	59	73.75%	20	71	31	43.66%
P17	23	80	42	52.50%	22	71	16	22.54%
P18	22	80	43	53.75%	23	71	17	23.94%
P19	3	80	78	97.50%	1	71	71	100.00%
P20	20	80	49	61.25%	19	71	32	45.07%
P21	15	80	65	81.25%	11	71	53	74.65%
P22	15	80	65	81.25%	6	71	62	87.32%
P23	21	80	46	57.50%	21	71	25	35.21%
MEAN			**64.26**	**80.33%**			**46.65**	**65.70%**

A Pearson test run on the data of identification and production yielded a positive correlation, *r*(22) = .864, significant at the .001 level (p = .000). A Spearman's Rank Order Correlation test also yielded a positive and significant result – *rho*(22) = .762, p = .000. The results indicate that the identification and production abilities were extremely related; and, thus, perceptual training might have affected production to a great extent as well. Figure 6.2 illustrates the relationship between identification and production, showing that the better the performance of a participant in the identification test the higher the number of accurate word-initial /s/-clusters production by that participant.

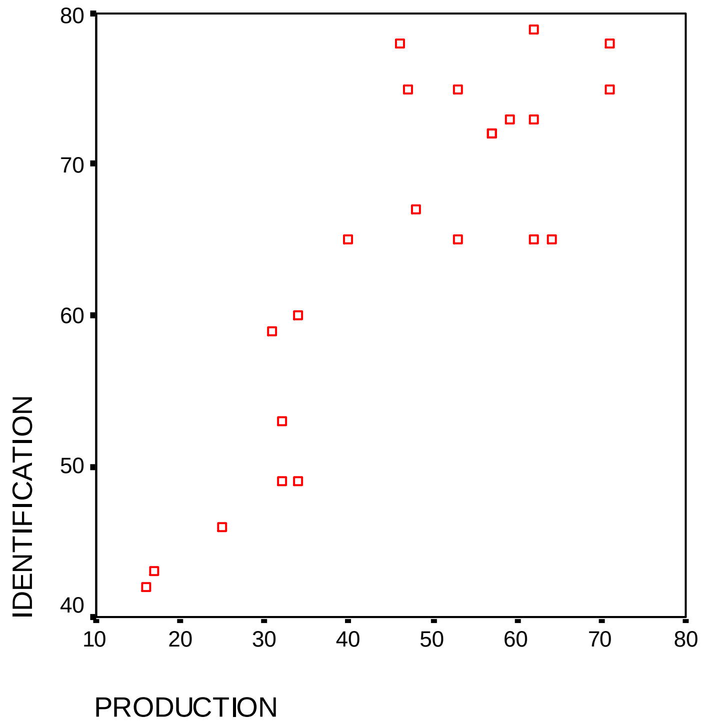


Figure 6.2 – Correlation between production and identification

Hypothesis 3.1 was confirmed in that a relationship between identification and production was found.

6.3.2 The relationship between identification and production by cluster type – H3.2

The identification test assessed the clusters tested in the phrase-reading test in the same phonological contexts they were presented there. Therefore, for the investigation of Hypothesis 3.2 the production tokens selected were those used in the identification test. Table 6.9 shows the raw scores and rates in the identification test and in the phrase-reading test by cluster.

Table 6.9 – Identification test and phrase-reading test by cluster

	Identification				Production			
	Rank	**N**	**Score**	**Rate**	**Rank**	**N**	**Score**	**Rate**
/sm/ smile	6	414	324	78.26%	6	92	34	36.96%
/sn/ snail	4	414	328	79.22%	5	92	39	42.39%
/sl/ slow	5	598	469	78.42%	4	92	46	50.00%
/s/+sonorant		**1426**	**1121**	**78.61%**		**276**	**119**	**43.11%**
/sp/ sport	1	138	123	89.13%	1	69	55	79.71%
/st/ stop	2	138	118	85.50%	1	69	55	79.71%
/sk/ scan	2	138	118	85.50%	3	69	46	66.67%
/s/+stop		**414**	**359**	**86.71%**		**207**	**156**	**75.36%**
MEAN		**1840**	**1480**	**80.43%**		**483**	**275**	**56.93%**

Correlation tests confirmed the relationship that can be inferred from Table 6.9. A Pearson Correlation Test yielded a significant result, $r(20) = .720$, p = .000, and a Spearman's Rank Order Correlation also yielded a significant result, $rho(20) = .668$, p = .001. Thus, Hypothesis 3.2 was corroborated.

6.3.3 The relationship between production and identification before and after training – H3.3

To investigate the hypothesis that the correlation between identification and production would be weaker after training, the data from all tasks were used as well as the data for each production task, separately (except data from the interview). Table 6.10 shows the raw scores and rates in the pre- and posttests in identification and production.

Table 6.10 – Identification and production before and after training

	Identification					**Production**				
			pretest		**posttest**			**Pretest**		**Posttest**
	N	**Score**	**Rate**	**Score**	**Rate**	**N**	**Score**	**Rate**	**Score**	**Rate**
P1	80	65	81.25%	77	96.25%	71	64	90.14%	68	95.77%
P2	80	73	91.25%	79	98.75%	71	59	83.10%	71	100.00%
P3	80	65	81.25%	79	98.75%	71	40	56.34%	67	94.37%
P4	80	53	66.25%	68	85.00%	71	32	45.07%	65	91.55%
P5	80	75	93.75%	79	98.75%	71	47	66.20%	67	94.37%
P6	80	60	75.00%	68	85.00%	71	34	47.89%	57	80.28%
P7	80	73	91.25%	80	100.00%	71	62	87.32%	67	94.37%
P8	80	75	93.75%	77	96.25%	71	53	74.65%	67	94.37%
P9	80	67	83.75%	73	91.25%	71	48	67.61%	68	95.77%
P10	80	49	61.25%	67	83.75%	71	34	47.89%	65	91.55%
P11	80	72	90.00%	75	93.75%	71	57	80.28%	71	100.00%
P12	80	79	98.75%	79	98.75%	71	62	87.32%	71	100.00%
P13	80	75	93.75%	76	95.00%	71	71	100.00%	71	100.00%
P14	80	72	90.00%	76	95.00%	71	57	80.28%	68	95.77%
P15	80	78	97.50%	79	98.75%	71	46	64.79%	68	94.37%
MEAN		**69**	**85.92%**	**75**	**94.33%**		**51**	**71.92%**	**67**	**94.84%**

Pearson correlation tests run on identification and production were significant for before training and after training data – *r*(14) = .714, p = .003 and *r*(14) = .614, p = .015, respectively. Spearman's Rank Order Correlation tests, however, showed that the relationship was significant only before training, *rho*(14) = .524, p = .044. The results for the posttest indicated a weak and non-significant relationship – *rho*(14) = .292, p =.291. The positive correlation found in the pretest was sufficient to justify an identification perceptual training. The lack of significance for the scores obtained after training may have happened because participants reached nearly 100% accuracy in production and the gain scores in identification varied more among the participants. For the story-reading task and identification, the data reached a stronger correlation after training, *r*(14) = .710 , p = .003, than it had before training , *r*(14) = .174, p = .534. For the phrase-reading task which was a more controlled task, on the other hand, the relationship turned from highly significant , *r*(14) = .750 p = . 001 to non-significant – *r*(14) = .329, p = .231. Since the phrase-reading task was responsible for 45 of the 71 tokens produced, the relationship with the paragraph reading test, the story reading test, and the interview should also be taken into account. It seems that in more natural conditions where participants do not pay much attention to form, the relationship was still present. The results of this investigation seem to indicate that it may be easier to modify one's own production by paying attention to it, that is, using self-monitoring strategies, than to modify one's ability to perceive the non-native contrasts just by paying more attention.

6.3.4 The relationship between production and discrimination – H3.4

Hypothesis 3.4 aimed at investigating the relationship between production and discrimination. Table 6.11 displays the raw scores and rates obtained by each participant in the production and discrimination pretests.

Table 6.11 – Results in the reading tasks and in the discrimination test

	PRODUCTION				DISCRIMINATION			
	Rank	**N**	**Score**	**Rate**	**Rank**	**N**	**Score**	**Rate**
P1	3	71	64	90.14%	15	84	57	67.86%
P2	7	71	59	83.10%	6	84	68	80.95%
P3	15	71	40	56.34%	11	84	65	77.38%
P4	19	71	32	45.07%	18	84	55	65.48%
P5	13	71	47	66.20%	11	84	65	77.38%
P6	17	71	34	47.89%	19	84	50	59.52%
P7	6	71	62	87.32%	13	84	62	73.81%
P8	11	71	53	74.65%	3	84	71	84.52%
P9	12	71	48	67.61%	14	84	61	72.62%
P10	17	71	34	47.89%	21	84	44	52.38%
P11	9	71	57	80.28%	8	84	66	78.57%
P12	6	71	62	87.32%	1	84	80	95.24%
P13	1	71	71	100.00%	8	84	66	78.57%
P14	9	71	57	80.28%	12	84	64	76.19%
P15	14	71	46	64.79%	4	84	69	82.14%
P16	20	71	31	43.66%	17	84	56	66.67%
P17	22	71	16	22.54%	23	84	37	44.05%
P18	23	71	17	23.94%	22	84	38	45.24%
P19	1	71	71	100.00%	1	84	80	95.24%
P20	19	71	32	45.07%	21	84	44	52.38%

P21	11	71	53	74.65%	11	84	65	77.38%
P22	6	71	62	87.32%	6	84	68	80.95%
P23	21	71	25	35.21%	17	84	56	66.67%
MEAN			**47**	**65.70%**			**60**	**71.79%**

A Pearson test yielded a highly significant and positive correlation between production and discrimination, *r*(22) = .818, p = .000. A Spearman's Rank Order correlation also yielded a highly significant and positive correlation, *rho*(22) = .739, p = .000. The results indicate that around 60% of what happens in production and in discrimination is related following the same tendency of the relationship between production and identification. The relationship within the domain of perception, that is, between identification and discrimination was much higher, though, suggesting that the relationship across domains is weaker. The 40% of production which is not related to discrimination and identification abilities may be related to articulatory difficulties and the influence of idiolect. Figure 6.3 illustrates the correlation between production and discrimination and shows the great individual variation in both domains.

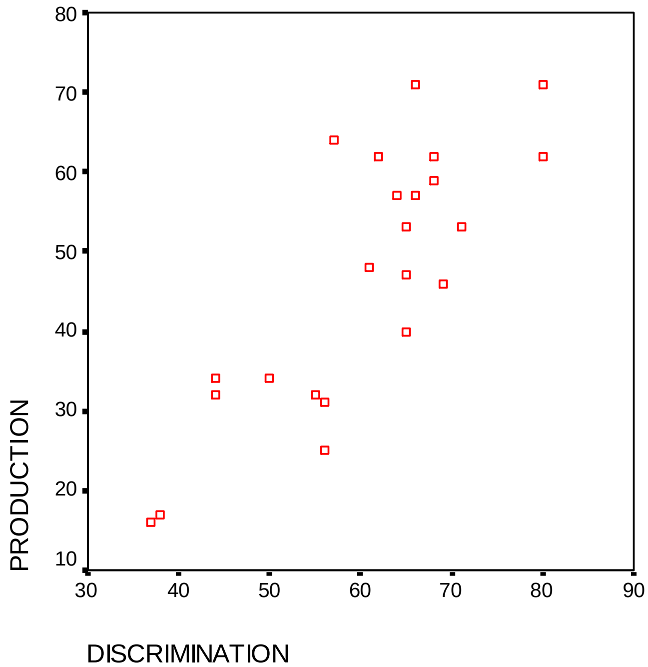


Figure 6.3 – Correlation between production and discrimination by participant

Since the discrimination stimuli comprised only a subset of the phrase-reading task stimuli, an analysis of that specific subset was conducted.

Table 6.12 – Results in the production and in the discrimination pretests

		PHRASE-READING				**DISCRIMINATION**		
		N	**Score**	**Rate**		**N**	**Score**	**Rate**
How stop	1	23	18	78.26%	1	184	155	84.24%
Move stop	2	23	17	73.91%	3	184	136	73.91%
		46	**35**	**76.08%**		**368**	**291**	**79.07%**
How slow	3	23	9	39.13%	2	460	344	74.78%
Move slow	4	23	8	34.78%	4	1104	764	69.20%
		46	**17**	**36.96%**		**1564**	**1108**	**70.84%**
Total		**92**	**52**	**56.52%**		**1932**	**1399**	**72.41%**

There was a great difference between the production of tokens containing the word ‘stop’ and those containing the word ‘slow’. However, the same was not found for discrimination. Also, a Spearman’s Rank Order Correlation Test yielded no correlation between discrimination and production by token, *rho* = .800, p = .200. Thus, the hypothesis that there would be a relationship between production and discrimination was corroborated regarding participants but not regarding cluster type.

6.3.5 The relationship between production and discrimination before and after training – H3.5

As previously demonstrated in section 6.3.4, production and discrimination are related to a great extent. Hypothesis 3.5 proposed that the relationship between these abilities would reduce after training. Table 6.13 displays the data obtained from the production and discrimination tasks in the pretest and posttest phases.

Table 6.13 Production and discrimination tests in both pretest and posttest phases by participant

					Production					Discrimination
			pretest		posttest			pretest		Posttest
	N	Score	Rate	Score	Rate	N	Score	Rate	Score	Rate
P1	71	64	90.14%	68	95.77%	84	57	67.86%	76	90.48%
P2	71	59	83.10%	71	100.00%	84	68	80.95%	76	90.48%
P3	71	40	56.34%	67	94.37%	84	65	77.38%	80	95.24%
P4	71	32	45.07%	65	91.55%	84	55	65.48%	67	79.76%
P5	71	47	66.20%	67	94.37%	84	65	77.38%	65	77.38%
P6	71	34	47.89%	57	80.28%	84	50	59.52%	63	75.00%

P7	71	62	87.32%	67	94.37%	84	62	73.81%	83	98.81%
P8	71	53	74.65%	67	94.37%	84	71	84.52%	79	94.05%
P9	71	48	67.61%	68	95.77%	84	61	72.62%	77	91.67%
P10	71	34	47.89%	65	91.55%	84	44	52.38%	51	60.71%
P11	71	57	80.28%	71	100.00%	84	66	78.57%	77	91.67%
P12	71	62	87.32%	71	100.00%	84	80	95.24%	80	95.24%
P13	71	71	100.00%	71	100.00%	84	66	78.57%	74	88.10%
P14	71	57	80.28%	68	95.77%	84	64	76.19%	72	85.71%
P15	71	46	64.79%	68	94.37%	84	69	82.14%	82	97.62%
MEAN		**51**	**71.92%**	**67**	**94.84%**		**63**	**74.84%**	**73**	**87.46%**

Before training, a Pearson correlation test and a Spearman's Rank Order Correlation test ran on production and discrimination scores yielded respectively, weak to insignificant correlations, *r*(14) = .591, p = .020 and *rho*(14) = .437, p = .107. After training the correlations obtained were even weaker as in the case of the identification scores. A barely significant correlation was yielded by a Pearson Correlation test – *r*(14) = .515, p = .049 and an insignificant correlation was yielded by a Spearman's Rank Order Correlation test– *rho*(14) = .321, p = .224.

The hypothesis proposed a reduction in the relationship after training and; thus, it was confirmed.

In sum, the relationship within the perception domain seems to be stronger than the relationship across domains. There was a wide variation among participants' improvement in the different tests resulting in modifications in the correlations from the pre- to posttest phase. Without intervention of the training, the correlations were stronger and more significant. This cannot be taken as unquestionable evidence that the training is more effective for production than for perception, but it indicates that monitoring can help learners overcome articulatory barriers. In order to investigate whether participants start producing accurate word-initial /s/-clusters more frequently when they are not consciously monitoring their own speech their productions in non-testing situations should be analyzed, which was not possible in the present research.

6.4 Effects of training

The fourth research question dealt with the main objective of the study - to investigate effects of perceptual training on word-initial /s/-clusters on the pronunciation of Brazilian Portuguese learners of English. This question triggered six hypotheses.

Hypothesis 4.1: There will be improvement in the identification test from the pretest to the posttest.

Hypothesis 4.2: There will be transfer of improvement (in the identification task) to the discrimination test.

Hypothesis 4.3: There will be transfer of improvement to production, that is, there will be improvement in production from the pretest to the posttest.

Hypothesis 4.4: There will be a greater reduction of prothesis than of voicing.

Hypothesis 4.5: Improvement in the perception and production tests for the untrained clusters will not differ from improvement for the trained clusters.

Hypothesis 4.6: There will be retention of improvement in perception and production after eight months.

First, the results of the control group are going to be displayed and discussed. Then, each hypothesis is going to be addressed individually analyzing data of the experimental group.

6.4.1 Results of the control group

A control group was included in the study in order to set a parameter for the improvement which could be found as the result of a training by the experimental group. The intention was to discard (1) improvement caused by task effect, and (2) learning promoted by test-taking. It would not be considered bad that learners benefited from the testing, but it was necessary to understand how much improvement could be attributed to testing itself and how much could be attributed to the training program. Table 6.14 displays the results in the pre- and posttests for the control group.

Table 6.14 – Results in the pre- and posttests for the control group

	IDENTIFICATION					**DISCRIMINATION**					**PRODUCTION**				
	N	**PRE**		**POST**		**N**	**PRE**		**POST**		**N**	**PRE**		**POST**	
P16C	80	59	73.75%	59	73.75%	84	56	66.67%	56	66.67%	71	31	43.66%	40	56.34%
P17C	80	42	52.50%	43	53.75%	84	37	44.05%	35	41.67%	71	16	22.54%	16	22.54%
P18C	80	43	53.75%	42	52.50%	84	38	45.24%	38	45.24%	71	17	23.94%	17	23.94%
P19C	80	78	97.50%	78	97.50%	84	80	95.24%	80	95.24%	71	71	100%	71	100%
P20C	80	49	61.25%	54	67.50%	84	44	52.38%	44	52.38%	71	32	45.07%	40	56.34%
P21C	80	65	81.25%	66	82.50%	84	65	77.38%	64	76.19%	71	53	74.65%	55	77.46%
P22C	80	65	81.25%	65	81.25%	84	68	80.95%	67	79.76%	71	62	87.32%	61	85.92%
P23C	80	46	57.50%	44	55.00%	84	56	66.67%	50	59.52%	71	25	35.21%	27	38.03%
MEAN		**55**	**69.84%**	**56**	**70.47%**		**55**	**66.07%**	**54**	**64.58%**		**38**	**54.05%**	**41**	**57.57%**

The control group performed worse than the experimental group in the pre and posttest, and therefore had a larger room for improvement. According to Yeon (2004), weaker learners benefit more from training, so participants in the control group had a greater chance of improvement than participants in the experimental group. Contrary to that, however, the gain score for the control group in identification was smaller than 1%, in production, it was only 3.53%, and in discrimination no gain occurred.

Wilcoxon Signed Ranks tests run on the data yielded non-significant results ($p > .05$) for the three tests – Z = 1.761 for production, Z = .412 for identification, and Z = 1.841 for discrimination. Since four out of eight participants had a slight improvement in production and three had a slight improvement in identification, it can be concluded that these learners may have had some awareness of the error they were producing in the pretest through the tests. However, as the statistical tests indicated, this awareness was not sufficient to form a new sound category. Thus, the improvement found for the experimental group can be attributed to training effects.

6.4.2 Improvement in the identification test for the experimental group – H4.1

The perceptual training task and the identification test had the same format. The differences were that input from the talker most frequently used in the test was not included in the training, and that the test included both trained and untrained clusters. Improvement in identification may be justified by task effect, but improvement in the untrained clusters would mean gain in the ability to identify the addition of a vowel and voicing of the /s/ in word-initial /s/-clusters, that is, differences in the suprasegmental structure – the syllable – and in the segmental feature – voicing. Figure 6.4 illustrates improvement in the identification test from pre to posttest.

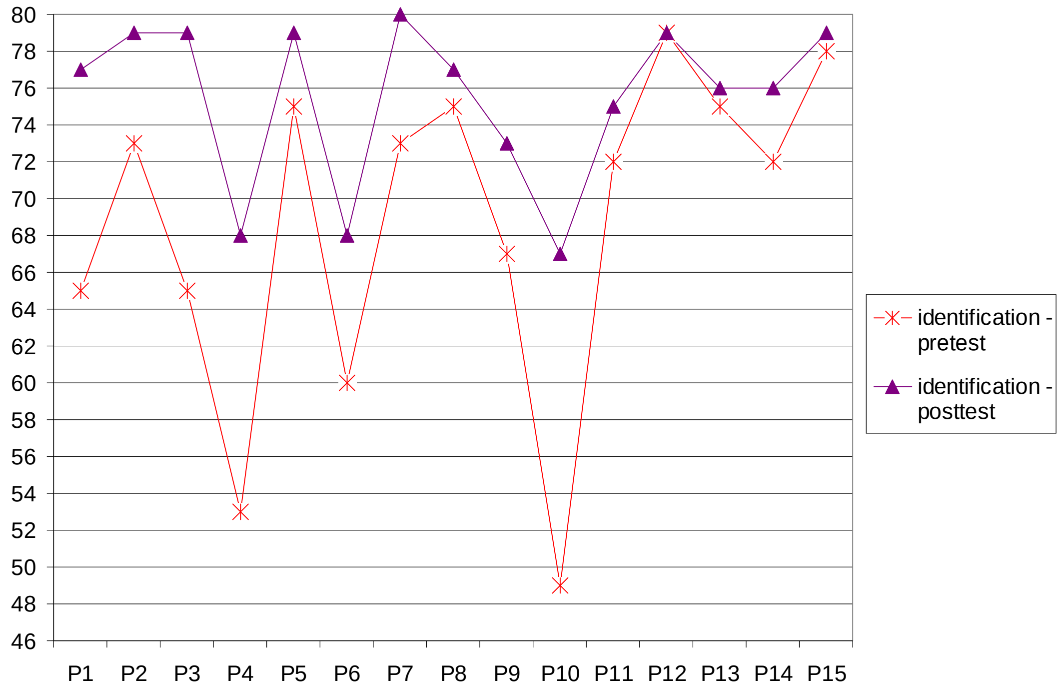


Figure 6.4 – Scores in the identification pre and posttest by participant

Figure 6.4 shows that individual variation was wider in the pretest than in the posttest. The only participant who did not improve from the pretest to the posttest was P12, who already had an almost perfect score in the pretest. The gain score in the identification test was 8.41% which corresponded to 59% of the room for improvement. The simple fact that there was improvement in the identification test implies generalization to an unfamiliar talker because an unfamiliar talker produced the great majority of trials in the identification test. Wilcoxon Signed Ranks tests ran on pretest and posttest scores yielded significant results when the data was tabulated by participants, Z= 3.298, p =.001, and when the data was tabulated by phrases, Z = 3.367, p = .001. As illustrated by Figure 6.5, out of 21 phrases only four did not yield improvement in identification from pre to posttest.

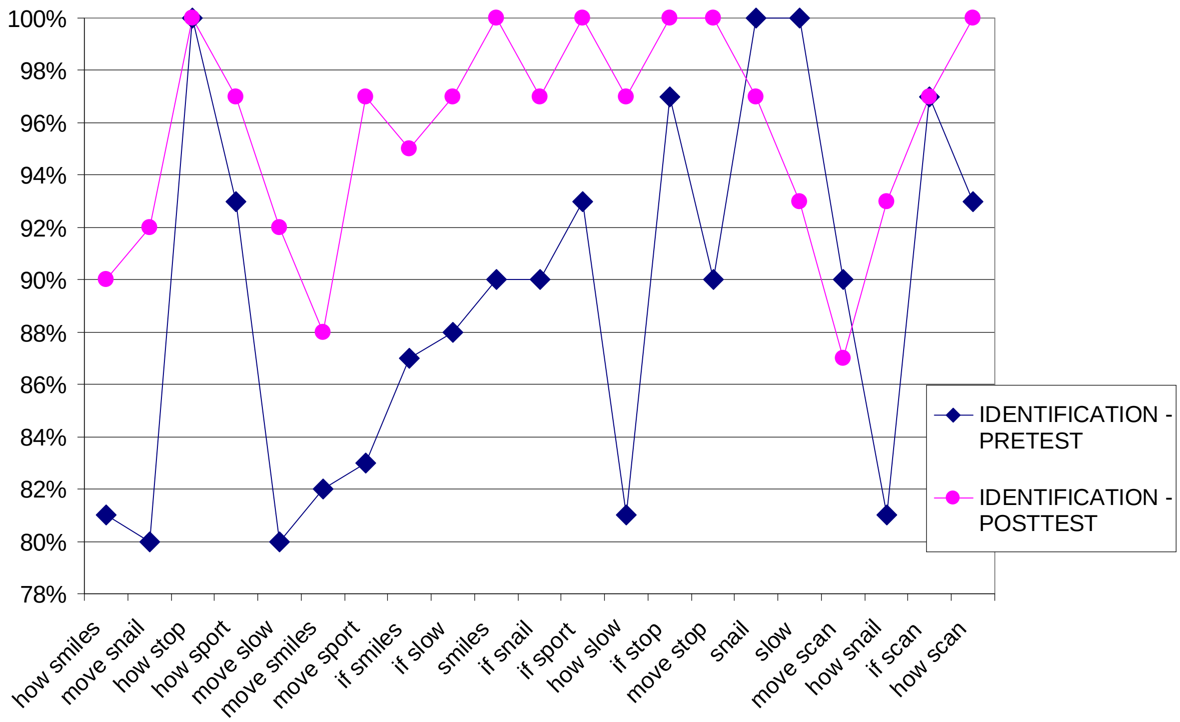


Figure 6.5 – Scores in identification pre and posttest by phrase

6.4.3 Transfer of improvement in identification to discrimination – H4.2

As previously shown and discussed in section 6.2.1, the abilities of identifying and discriminating word-initial /s/-clusters are extremely related. The correlation scores yielded by a Pearson and a Spearman test were $r(22) = .904$, p = .000. and $rho(22) = .893$ p = .000, respectively. Thus, it was expected that improvement in identification would imply improvement in discrimination. The second hypothesis regarding effects of training was that there would be transfer of improvement to the discrimination test. Figure 6.6 illustrates the generalization of improvement corroborating the hypothesis.

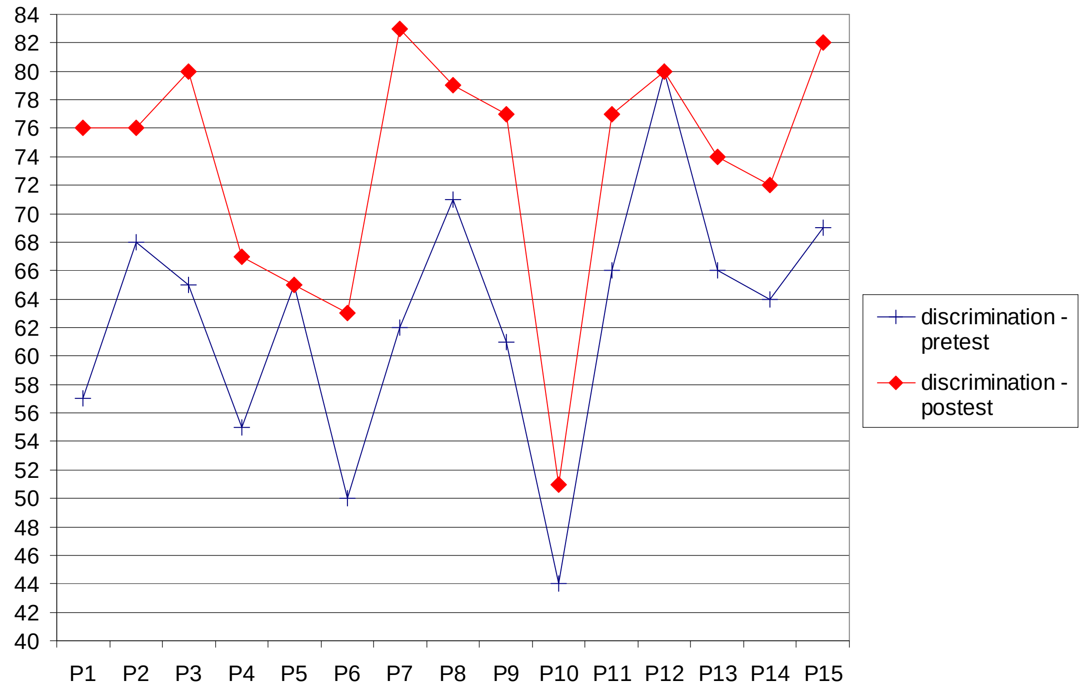


Figure 6.6 – Scores in discrimination for pre- and posttests by participant

Figure 6.6 shows that only two participants (P5 and P12) did not improve in the discrimination test. In comparison to Figure 6.4, Figure 6.6 indicates that the scores in the discrimination task were lower than in the identification test as previously displayed in Table 6.7. The gain score for discrimination was 12.62% which even though higher than the gain score obtained for the identification task, corresponded to a lower proportion of the room for improvement – 50%. A Wilcoxon Signed Ranks test yielded a significant difference between pre- and posttest – Z= 3.191, p = .001. This result indicates that there was a significant improvement in discrimination. Therefore, there was transfer of improvement to discrimination corroborating the second hypothesis of effects of training. The perceptual identification training seems to have changed how participants weighed the cues of the sounds in their discrimination from sounds which are not contrasting in Brazilian Portuguese. It seems that the training developed participants sensitivity to what was considered irrelevant before training.

6.4.4 Transfer of improvement in identification to production – H4.3

In order to verify whether there was transfer of improvement in identification to production, results from the four production tests will be discussed: the story-reading test, the paragraph-reading test, the phrase-reading test, and the interview. Also, the overall production results excluding the interview data were discussed since number and type of clusters produced in the interview varied among the participants. Figure 6.7 illustrates general improvement in production assessed by the reading tests.

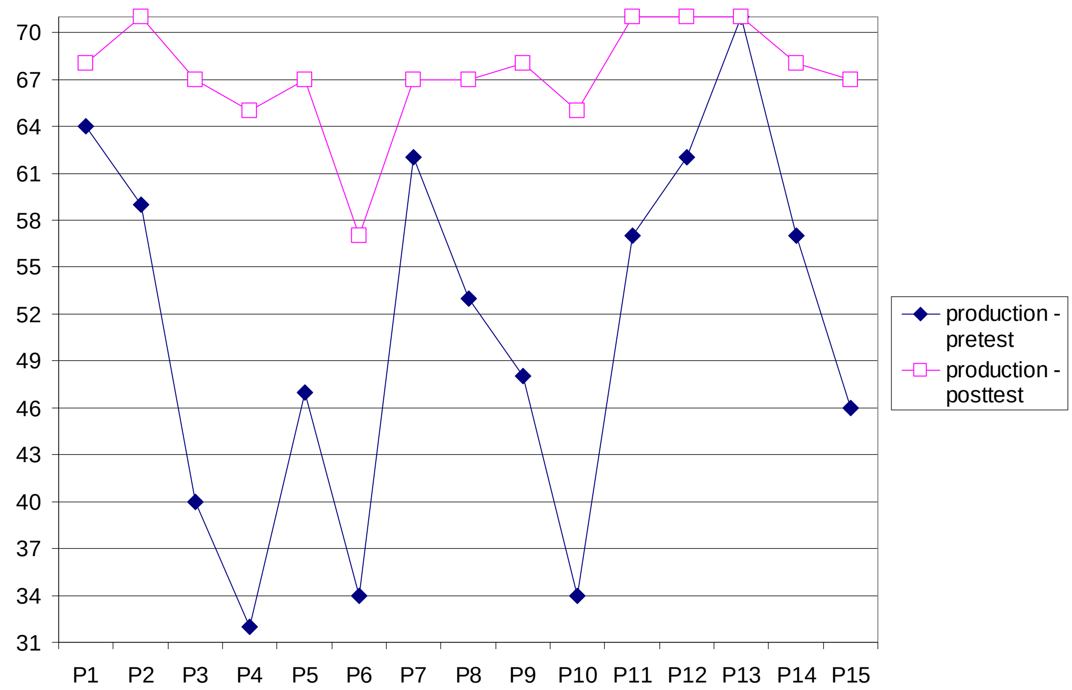


Figure 6.7 – Production scores in the pre and posttests by participants

Figure 6.7 shows the reduction of variation in the participants' performance from the pre- to the posttest. It also displays a great improvement in the production of all participants but P13 who had a perfect score in the pretest, and consequently, no room for improvement. The gain score in production was 22.92% which corresponded to 81% of the room for improvement. Production actually improved more than perception probably because production benefited from the improvement in perception and from the awareness of the accurate production of word-initial /s/-clusters which provided learners with tools to monitor their own speech. The awareness mentioned here refers to the awareness raised by the training program and by metalanguage. As mentioned in the introduction of the present chapter, mere awareness of the rule tends not to lead to better pronunciation (Barbara Baptista in personal communication, 2006).

A Wilcoxon Signed Ranks test run on the production scores of pre- and posttest yielded a significant result, $Z = 3.297$, $p = .001$. This corroborates the hypothesis that there would be transfer of improvement in identification to production.

Figure 6.8 shows that improvement was also found for the paragraph-reading test.

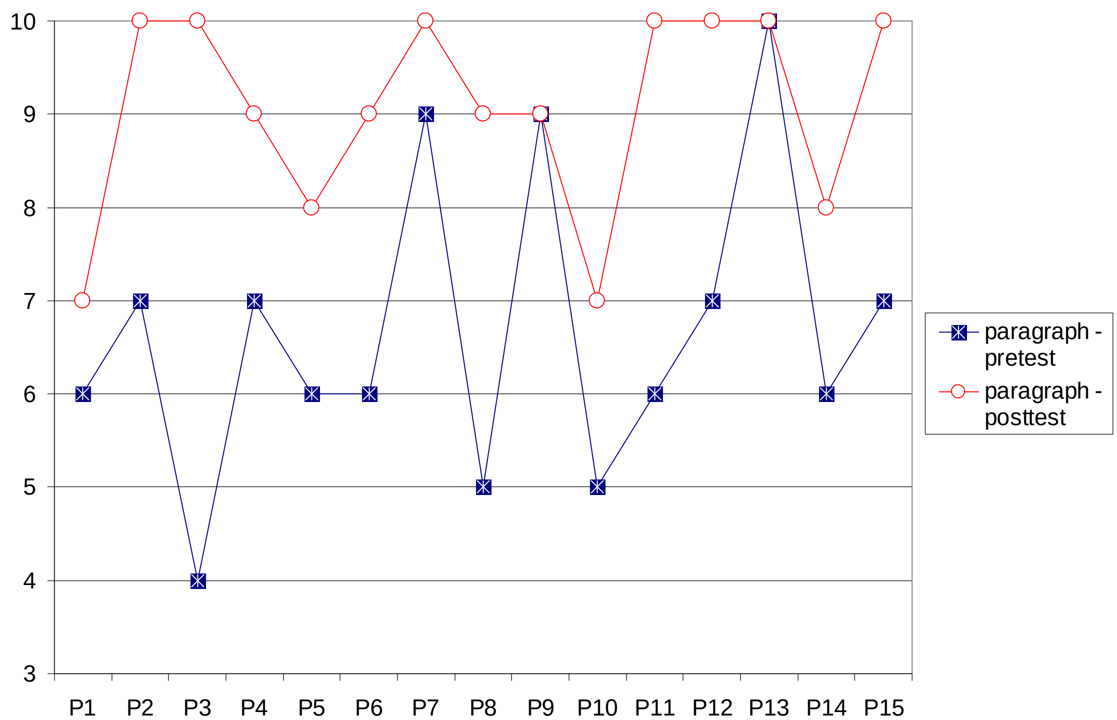


Figure 6.8 – Results in the paragraph-reading task in pre- and posttests

Also, A Wilcoxon Signed Ranks Test ran on the data of the paragraph-reading task indicated that the improvement was significant: $Z = 3.201$, $p = .001$.

Figure 6.9 shows that only P4 reduced the number of correct productions in the story-reading task from pre- to posttest, and the reduction was small.

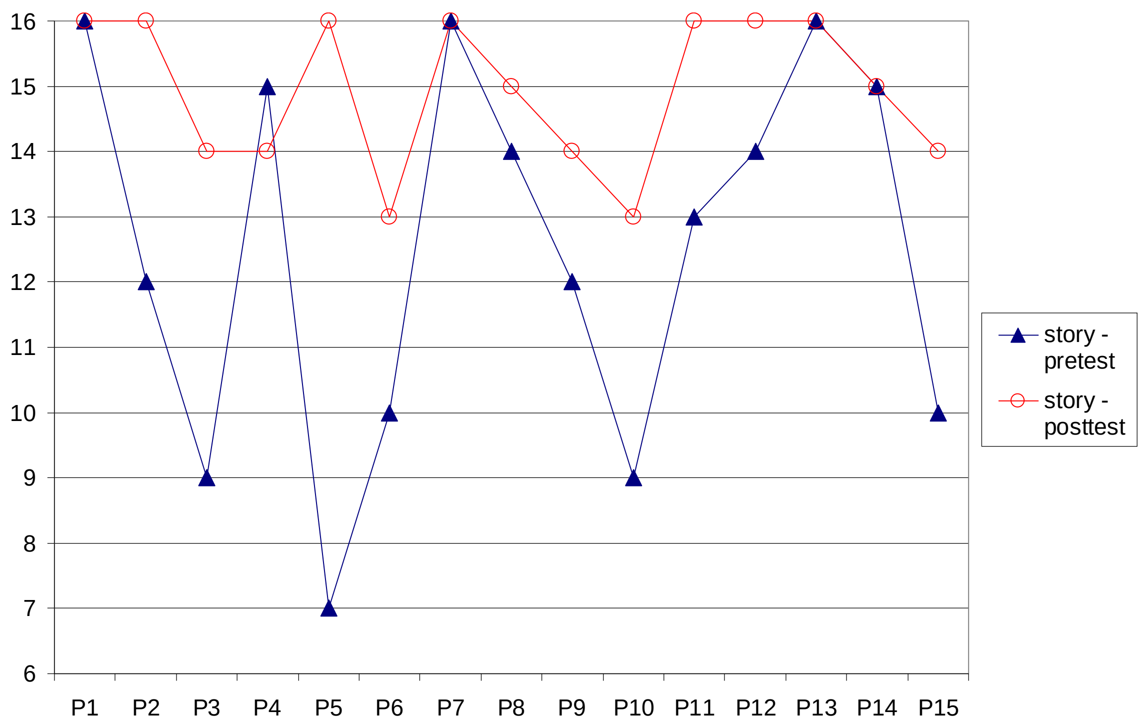


Figure 6.9 – Results in the story-reading task in pre- and posttests by participant

A Wilcoxon Signed Rank test yielded a positive and significant improvement – Z = 2.810, p = .005.

Figure 6.10 shows the results of the phrase-reading task in the pre- and posttest phases.

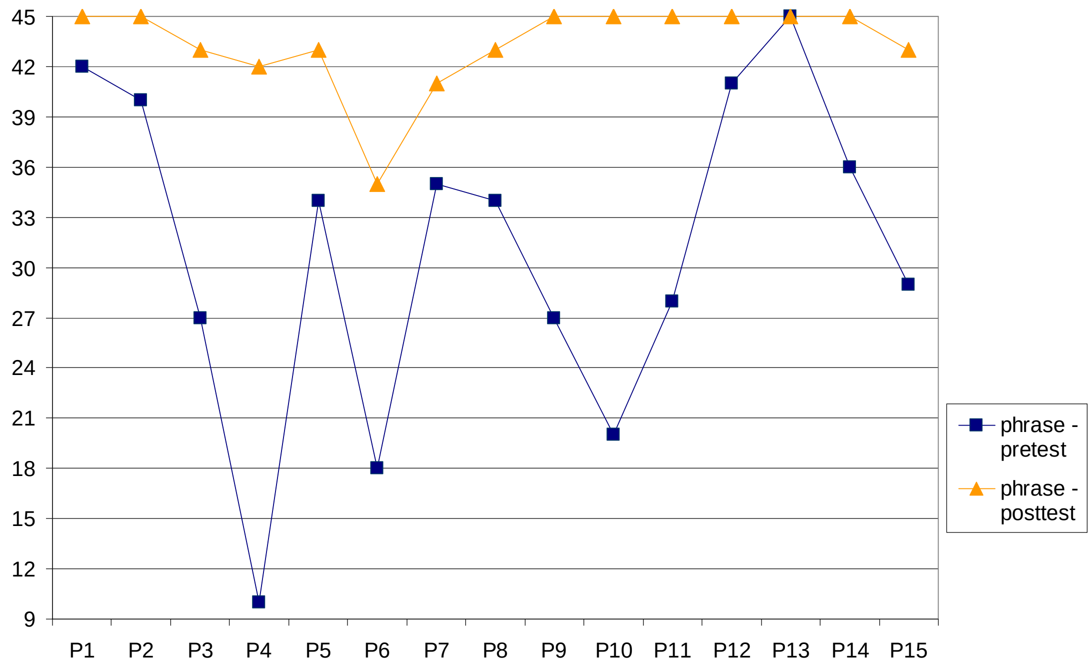


Figure 6.10 – Results in the phrase-reading task in the pre- and posttest

Eight participants obtained a perfect score in the phrase-reading test in the posttest. A Wilcoxon Signed Ranks test indicated that there was improvement in production – Z = 3.300, p = .001. By comparing the Z scores obtained for the three tasks, it can be noticed that the phrase-reading task was the test where there was the highest improvement followed by the paragraph-reading test, and then by the story-reading task. Thus, the tests where the possibility of control and monitoring were higher had the greatest improvement. Wilcoxon Signed Ranks Tests ran on the scores of proportion of the room for improvement yielded significance only for the phrase-reading test and the story-reading test, Z = 2.310, p = .021. No difference was found for the story-reading and the paragraph-reading tasks, Z = .891, p=.373, and for the phrase-reading and the paragraph-reading tasks, Z = 1.511, p = .131.

6.4.4.1 The interview task

Interviews are closer to natural speech than reading-tasks. One of the characteristics of natural speech is the variability in type and amount of production. Even though the questions used in the interview were prepared in a way to elicit the production of word-initial /s/-clusters, the answers varied from one participant to another and from the pre- to the posttests because the researcher had no strict control over the productions. The data obtained are displayed in tables 6.15 and 6.16 below by participant and cluster type.

The words elicited beginning in /s/+stop were ‘school’, ‘special’, ‘spent’, ‘spoon’, ‘stable’, ‘Stallone’, ‘stars’, ‘starting’, ‘stay’, ‘stereo’, ‘still’, ‘stop’, ‘storm’, ‘stove’, ‘student’, ‘study’, ‘studying’, and ‘stuff’. Table 6.15 displays the results for /sC/ in the interview in the pre- and posttests by participant.

The words beginning in /sCC/ elicited were ‘spring’, ‘street’, and ‘strong’. Table 6.16 displays the results for /sCC/ in the interview in the pre-and posttests by participant.

The words beginning in /s/+sonorant elicited were ‘sleep’, ‘slow’, ‘slowly’, ‘small’, ‘smile’, ‘smiles’, and ‘snow’. Table 6.17 displays the results for /s/+sonorant in the interview in the pre-and posttests by participant.

Table 6.15 – Results for /s/+stop clusters in the interview

	/sp/									/st/								/sk/
			Pretest			**posttest**			**pretest**			**posttest**			**pretest**			**posttest**
	N	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**
P1	-	-	-	-	-	-	3	0	100%	5	0	100%	1	0	100%	-	-	-
P2	1	0	100%	1	0	100%	5	0	100%	5	0	100%	-	-	-	-	-	-
P3	-	-	-	-	-	-	3	0	100%	4	0	100%	-	-	-	-	-	-
P4	-	-	-	-	-	-	5	0	100%	4	0	100%	-	-	-	-	-	-
P5	-	-	-	-	-	-	9	/iz/	89%	7	0	100%	-	-	-	-	-	-
P6	-	-	-	-	-	-	4	0	100%	3	0	100%	-	-	-	-	-	-
P7	1	0	100%	1	0	100%	6	/is/	83%	5	0	100%	-	-	-	-	-	-
P8	-	-	-	-	-	-	4	/is/	75%	6	0	100%	-	-	-	-	-	-
P9	-	-	-	-	-	-	5	0	100%	3	0	100%	-	-	-	-	-	-
P10	1	0	100%	-	-	-	3	0	100%	3	0	100%	-	-	-	-	-	-
P11	3	0	100%	-	-	-	6	0	100%	7	0	100%	-	-	-	-	-	-
P12	2	0	100%	1	0	100%	10	0	100%	8	0	100%	-	-	-	-	-	-
P13	1	0	100%	-	-	-	6	0	100%	4	0	100%	-	-	-	-	-	-
P14	1	0	100%	1	0	100%	7	/is/	86%	7	0	100%	-	-	-	-	-	-
P15	1	0	100%	1	0	100%	5	0	100%	5	0	100%	-	-	-	-	-	-
TOTAL	**11**	**0**	**100%**	**5**	**0**	**100%**	**81**	**4**	**95%**	**76**	**0**	**100%**	**1**	**0**	**100%**	**-**	**-**	**-**

Few modifications in /s/+stop clusters occurred – four in the pretest and none in the posttest. The amount of errors was small and 100% of the room for improvement was used.

Table 6.16 – Results for /sCC/ in the interview

	/spr/											/str/
			Pretest			**Posttest**			**pretest**			**Posttest**
	N	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**
P1	4	0	100%	2	0	100%	1	0	100%	1	0	100%
P2	1	0	100%	3	0	100%	1	0	100%	3	0	100%
P3	1	0	100%	1	0	100%	1	0	100%	1	0	100%
P4	1	0	100%	3	0	100%	2	0	100%	1	0	100%
P5	1	0	100%	2	0	100%	1	0	100%	1	0	100%
P6	1	0	100%	1	0	100%	1	0	100%	1	0	100%
P7	1	0	100%	1	0	100%	1	0	100%	1	0	100%
P8	1	0	100%	1	0	100%	-	-	-	1	0	100%
P9	1	0	100%	1	0	100%	-	-	-	-	-	-
P10	1	0	100%	1	0	100%	-	-	-	-	-	-
P11	3	0	100%	1	0	100%	3	0	100%	1	0	100%
P12	1	0	100%	1	0	100%	1	0	100%	1	0	100%
P13	1	0	100%	1	0	100%	1	0	100%	1	0	100%
P14	2	0	100%	1	0	100%	1	/is/	0%	1	0	100%
P15	1	0	100%	1	0	100%	1	0	100%	1	0	100%
TOTAL	**21**	**0**	**100%**	**19**	**0**	**100%**	**15**	**1**	**93%**	**15**	**0**	**100%**

The number of modifications in /sCC/ was even smaller than in /s/+stop – there was only one error in the pretest. However, the amount of productions obtained was smaller as well. Again, 100% of the room for improvement was used.

Table 6.17 – Results for /s/+sonorant in the interview

	[sm]						[sn]						[sl]					
	pretest			**posttest**			**Pretest**			**posttest**			**pretest**			**Posttest**		
	N	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**
P1	2	[iz] [z]	0%	1	[z]	0%	4	~	100%	1	~	100%	3	[z] [z] [z]	0%	1	~	100%
P2	1	[z]	0%	1	~	100%	-	..	-	2	~	100%	-	..	-	1	~	100%
P3	2	[iz]	50%	2	~	100%	-	..	-	1	~	100%	-	..	-	1	~	100%
P4	2	[is]	50%	2	~	100%	-	..	-	1	~	100%	-	..	-	1	~	100%
P5	1	[z]	0%	1	[z]	0%	-	..	-	-	..	-	-	..	-	-	..	-
P6	2	[z][z]	0%	4	[z]	75%	2	[iz] [iz]	0%	1	[z]	0%	2	[z] [z]	0%	2	~	100%
P7	2	[z][z]	0%	1	~	100%	2	~	100%	1	~	100%	1	~	100%	1	~	100%
P8	1	[z]	0%	2	~	100%	1	~	100%	1	~	100%	1	[z]	0%	1	~	100%
P9	1	[z]	0%	1	[z]	0%	-	..	-	1	~	100%	3	[z] [z] [iz]	0%	2	[iz]	50%
P10	1	[z]	0%	1	~	100%	-	..	-	-	..	-	1	[z]	0%	3	[z]	67%
P11	1	[iz]	0%	1	~	100%	2	[z]	50%	1	~	100%	1	[z]	0%	2	[z]	50%
P12	1	~	100%	1	~	100%	1	[z]	0%	1	~	100%	1	~	100%	1	~	100%
P13	1	~	100%	1	~	100%	1	~	100%	1	~	100%	1	~	100%	1	~	100%
P14	1	[iz]	0%	1	~	100%	1	[z]	0%	3	[z]	67%	3	[z] [z] [is]	0%	2	[z]	50%
P15	1	~	100%	1	~	100%	1	~	100%	1	~	100%	2	~	100%	2	~	100%
TOTAL	**20**	**15**	**25%**	**21**	**4**	**81%**	**15**	**5**	**67%**	**16**	**2**	**87%**	**19**	**14**	**26%**	**21**	**4**	**81%**

As in the reading tasks, /s/+sonorant clusters were more frequently modified in the interview. Since the rates in the pretest were low, the room for improvement was large and so were the gain scores obtained from the pre- to the posttest - /sm/: 56%; /sn/: 20%; and /sl/: 55%.

<u>Individual performance in the interview</u>

In the pretest, P1 produced prothesis with voicing once and voicing alone four times. All errors occurred in /s/+sonorant clusters, /sl/ and /sm/. Even though /sn/ was produced four times, it was not modified. In the posttest, only /sm/ was mispronounced and the only error was voicing. The most perceptually salient error – prothesis – did not occur. Production improved in the interview task. P1 improved in the reading tasks as well – from 90.14% in the pretest to 95.77% in the posttest. She was one of the children who participated in the study – 9 years old. She had a very good vocabulary and could answer all questions.

In the pretest, the only error of P2 was voicing /sm/, which was the only /s/+sonorant cluster produced. In the posttest, no errors were produced even though more words containing initial /s/+sonorant were elicited. In the reading tasks, the rate in the pretest was 83.10% and in the posttest was 100%.

P3 produced one error in the pretest - prothesis and voicing in /sm/ and no errors in the posttest. The only /s/+sonorant cluster produced in the pretest was /sm/. The three /s/+sonorant clusters were produced in the posttest. P3 also improved in the reading tests – from 56.34% to 94.37%. The number of errors was larger in the reading tests than in the interview, probably due to the difficult context and cluster type combinations included.

P4 produced prothesis once in the pretest when pronouncing /sm/, which was the only /s/+sonorant cluster produced. The other sample of /sm/ was accurately pronounced. In the posttest, no errors were produced. In the reading tasks, the improvement was from 45.07% to 91.55%.

P5 produced voiced /sm/ and voiced and epenthesized /st/. The voicing process in the /s/+stop clusters is rare, but possible. P5 repeated the voicing error producing voiced /sm/ in the posttest. In the reading tasks, the improvement was from 66.20% to 94.37.

P6 voiced the six /s/+sonorant clusters produced in the pretest, and /sn/ was voiced and epenthesized. In the posttest, no prothesis occurred and three out of seven /s/+sonorant clusters were accurately produced. Improvement was also found in the reading tasks – from 47.89% to 80.28%.

P7 produced one sample of /st/ with prothesis and two samples of /sm/ with voicing in the pretest. The clusters /sn/ and /sl/ were not modified. In the posttest, no errors occurred. In the reading tasks, the improvement was from 87.32% to 94.37%.

P8 voiced /sm/ and /sl/ and epenthesized /st/ in the pretest. Even increasing the number of productions in the posttest from 8 to 13, no errors were produced. P8 improved in the reading tasks from 74.65% to 94.37%.

All four productions of /s/+sonorant clusters in the pretest were modified by P9 – three were voiced and one was voiced and epenthesized. In the posttet, one instance of

/sl/ was epenthesized and voiced, and /sm/ was voiced. Improvement was also found in the reading tasks – from 67.61% to 95.77%.

In the pretest, P10 produced two samples of /sm/ and both were voiced. In the posttest, there were four productions of /s/+sonorant and only one was voiced. The improvement found in the reading tasks was from 47.89% to 91.55%. P10, an eleven-year old girl, was the second child in the experimental group. The starting point of P1 (the other child in the study) was much higher, even though the two children had the same number of years of formal instruction. Both P10 and P1 benefited from the training program.

In the pretest, P11 produced four /s/+sonorant clusters and three were modified. The cluster /sm/ underwent voicing and prothesis, the cluster /sl/ suffered voicing, and one out of two productions of /sn/ suffered voicing. In the posttest, the only modification he produced was voicing one of the two instances of /sl/. In the reading tests, P11 improved from 80.28% to 100%.

P12 produced only one error in the pretest – voicing /sn/. In the posttest, no errors occurred. In the reading task, the improvement was from 87.32% to 100%. P12 was the participant who had spent longer in an English speaking country – 1.5 years in Canada. Even so, she had considerable room for improvement in production, which was totally used, resulting in 100% accuracy in the posttest - in the interview and in the reading tests.

P13 was 100% accurate in the production of word-initial /s/-clusters in the interview and in the reading tasks in both pre- and posttests. He was included in the training program because he had room for improvement in the perception tasks.

In the pretest, P14 produced the three types of error – (1) prothesis in /st/ and /sl/, (2) voicing in /sl/ and /sn/, and (3) prothesis and voicing in /sm/. In the posttest, the only remaining error was voicing in /sl/ and /sn/. Also, four tokens of /s/+sonorant were accurately produced. In the reading tasks, the improvement was from 80.28% to 95.77%.

P15 produced no errors in the interview in the pre- or posttests. However, his performance in the reading tests in the pretest phase was only average – 64.79%. Most answers were short and straight to the point. In the posttest, the answers were longer and still errors did not occur, probably due to a positive effect of the training program, as happened in the reading tests resulting in a rate of 95.77% in the reading posttest.

The discussion about the influence of the level of formality of speech on L2 pronunciation accuracy is far from being resolved. Investigating final epenthesis production with Brazilian learners of English, Major (1986) and Koerich (2002) found that errors tended to decrease as the formality of the task increased (from the reading of texts, to sentences, and then to lists of words, in the former study and from free-speech to sentence-reading in the latter). Statistical treatment of Koerich's data showed that the difference between rates of epenthesis were not significant, though.

In the present study, the data revealed that, for some participants, the proportion of errors in the interview was smaller than in the other tasks – the paragraph-reading task and the phrase-reading task. Although the issue was not thoroughly examined here, it might be reasoned that the higher frequency of mispronunciations yielded in the more formal tasks (contrary to the two studies mentioned above) resulted from the combinations of difficult contexts and clusters in the texts, which did not occur in the interview.

The participants of the present study, especially those in the experimental group, had a high level of language proficiency and produced a higher rate of ‘voicing’ than of ‘prothesis’. Thus, the data might be taken to indicate that voicing is a more resistant error, whereas prothesis and paragoge (initial and final epenthesis) tend to be more common in the pronunciation of learners with a lower proficiency level (Major, 1986, 1992, 1996; Koerich, 2002).

The /s/+sonorant clusters were the most frequently modified clusters in the interview task, and there was no difference between /sC/ and /sCC/, the same tendencies found in the reading tests, as demonstrated in the investigation of Hypothesis 1.2. Voicing was the most frequent error in the interview task. Types of errors in the reading tasks are discussed below.

6.4.5 Improvement in production by type of error – H4.4

Hypothesis 4.4 suggested that the reduction of inappopriate prothesis would be higher than the reduction of inappopriate voicing. Table 6.18 displays the number of each error in the production tests by participant.

Table 6.18 – Number of occurrences of prothesis, voicing and their combination

		PROTHESIS		VOICING		PROTHESIS + VOICING	
	N	PRETEST	POSTTEST	PRETEST	POSTTEST	PRETEST	POSTTEST
P1	71	2	0	6	3	0	0
P2	71	0	0	11	0	1	0
P3	71	8	0	12	2	9	0
P4	71	21	3	5	2	14	1

P5	71	2	1	16	2	4	1
P6	71	13	10	6	2	17	1
P7	71	0	0	10	4	1	0
P8	71	1	0	15	4	2	0
P9	71	1	0	15	1	7	0
P10	71	1	0	32	5	3	1
P11	71	2	0	15	0	5	0
P12	71	0	0	9	0	0	0
P13	71	0	0	0	0	0	0
P14	71	4	0	8	2	1	1
P15	71	0	0	18	3	7	1
Total		**55**	**14**	**178**	**30**	**71**	**6**

Even though voicing tends to affect only /s/+sonorant clusters and prothesis tends to affect all cluster types, voicing was three times more frequent than prothesis in the pretest, and two times more in the posttest. The occurrence of prothesis combined with voicing was also larger than of prothesis alone in the pretest. Wilcoxon Signed Ranks tests showed that the reductions from the pre-test to the posttest were all significant – Z = 2.823, p = .005, for prothesis, Z = 3.300, p = .001, for voicing, and Z = 2.937, p = .003, for prothesis combined with voicing. A Wilcoxon Signed Ranks test run on "proportion of the room for improvement" for prothesis and voicing was contrary to the hypothesis – Z = 2.340, p = .013 – showing that the reduction in the occurrence of voicing was significantly larger than the reduction in the occurrence of prothesis. However, Table 6.18 shows that three participants continued to produce prothesis in the posttest and eleven participants continued to produce voicing. Thus, the reduction of voiced tokens was larger than the reduction of epenthesized tokens, but the reduction in the number of participants who produced prothesis was larger than in the number of participants who produced voicing.

6.4.6 Transfer of improvement in the trained to untrained clusters – H4.5

Untrained clusters were tested in the identification and in the production tests. In the identification test, the untrained clusters were /sk/ and /sn/. In the production tests, the untrained clusters were /sk/, /skr/, /spr/, and /sn/. The trained clusters present in both tests were /sp/, /st/, /sm/, and /sl/. Table 6.19 displays gain scores and the proportion of the room for improvement for trained and untrained clusters in the identification and production tests.

Table 6.19 – Trained and untrained clusters in the identification test

								Identification
			PRETEST		**POSTTEST**			
		N	**RAW SCORE**	**RATE**	**RAW SCORE**	**RATE**	**GAIN SCORE**	**P***
TRAINED CLUSTERS	/st/	90	86	95%	90	100%	5%	100%
	/sp/	90	81	90%	88	98%	8%	78%
	/sl/	390	325	83%	367	94%	11%	65%
	/sm/	330	226	68%	247	75%	7%	20%
	total	**900**	**718**	**80%**	**792**	**88%**	**8%**	**41%**
UNTRAINED CLUSTERS	/sk/	90	84	93%	85	94%	1%	17%
	/sn/	270	229	85%	254	94%	9%	61%
	total	**360**	**313**	**87%**	**339**	**94%**	**7%**	**55%**

* P stands for used proportion of the room for improvement

Mann-Whitney Tests run on gain scores and on proportion of the room for improvement yielded non-significant results, Z = .861, p = .389 and Z = 1.184, p = .237, respectively. The lack of significance indicates that there was transfer of improvement in identification to untrained clusters in that the improvement for the trained clusters was not different from the improvement for the untrained clusters.

Table 6.20 – Trained and untrained clusters in the production test

								Production
			PRETEST		**POSTTEST**			
		N	**RAW SCORE**	**RATE**	**RAW SCORE**	**RATE**	**GAIN SCORE**	**P***
TRAINED CLUSTERS	/st/	180	169	94%	179	99%	5%	91%
	/sp/	195	174	89%	177	91%	2%	14%
	/sl/	165	90	55%	156	95%	40%	88%
	/sm/	150	63	42%	141	94%	52%	90%
	Total	**690**	**496**	**72%**	**653**	**95%**	**23%**	**81%**
UNTRAINED CLUSTERS	/sk/	60	34	57%	58	97%	40%	92%
	/sn/	195	98	50%	154	79%	29%	58%
	/skɾ/	60	56	93%	60	100%	7%	100%
	/spɾ/	60	56	93%	59	98%	5%	75%
	total	**375**	**244**	**65%**	**331**	**88%**	**23%**	**66%**

* P stands for used proportion of the room for improvement

Mann-Whitney Tests run on gain scores and on proportion of the room for improvement for production failed to yield significance as well, Z = .227, p = .820 to yield and Z = .602, p = .547 respectively. The results confirm that there was generalization of improvement in production to the untrained clusters. Hypothesis 4.5 was corroborated in that no difference in the amount of improvement for trained and untrained clusters was found.

6.4.7 Retention of improvement after eight months – H4.6

Studies have investigated retention with one, three, five and six month follow-up tests. Studies investigating six-month retention usually have a three-month retention test as well. This measure might change results since learners' attention is called to the contrast in the middle of the six-month period. The longest interval between the posttest and the first retention test was five months given by Bettoni-Techio and Koerich (2008). The eight-month interval of the present study is groundbreaking. One of the greatest difficulties of carrying out such a long term study is the availability of participants. As explained in 5.4, eight out of fifteen participants took the eight-month retention test. Table 6.21 shows the results in the retention test.

Table 6.21 – Retention test

	Identification			**Discrimination**			**Production**		
	N	**Score**	**Rate**	**N**	**Score**	**Rate**	**N**	**Score**	**Rate**
P1	80	80	100%	84	76	90.48%	71	71	100%
P2	80	75	93.75%	84	71	84.52%	71	65	91.55%
P4	80	71	88.75%	84	66	78.57%	71	58	81.69%
P5	80	79	98.75%	84	76	90.48%	71	63	88.73%
P8	80	75	93.75%	84	79	94.05%	71	68	95.77%
P9	80	71	88.75%	84	78	92.86%	71	59	83.10%
P10	80	62	77.50%	84	49	58.33%	71	67	94.37%
P12	80	78	97.50%	84	79	94.05%	71	71	100%
MEAN		**74**	**92.34%**		**72**	**85.42%**		**65**	**91.90%**

Retention of improvement is discussed separately for each test in the three next subsections in the following order (1) retention in identification; (2) retention of the generalization to discrimination, and (3) retention of generalization to production.

6.4.7.1 Retention in identification

The improvement in identification from the pre- to the posttest was 8.41%, representing 59% of the room for improvement. After eight months the identification test was repeated to measure retention. Figure 6.11 illustrates the retention of improvement after eight months.

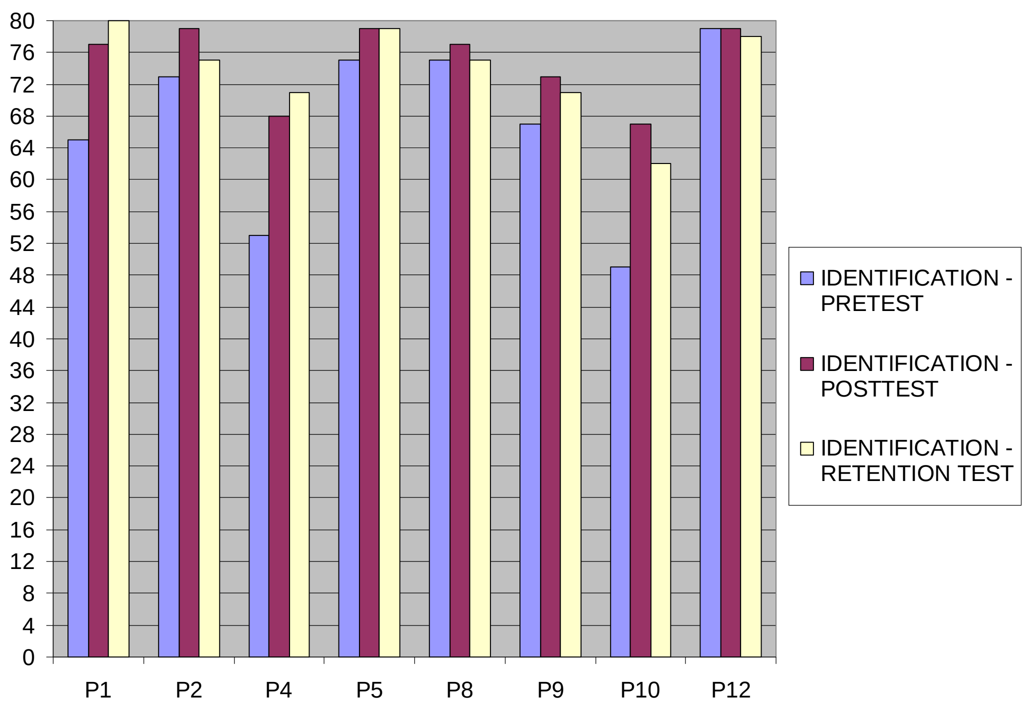


Figure 6.11 – Identification in the pre-, post, and retention tests

A Wilcoxon Signed Ranks test yielded a positive difference between the pretest and the retention test, Z = 2.201, p = .028, indicating that there was improvement; and no significant difference between the posttest and the retention test, Z = .848, p = 396, indicating that the improvement verified in the posttest was retained, and that no further improvement occurred since the posttest.

6.4.7.2 Retention in discrimination

The improvement in discrimination from the pre- to the posttest was 12.62%, representing 50% of the room for improvement. Figure 6.12 illustrates the retention of improvement detected in the eight-month follow-up test.

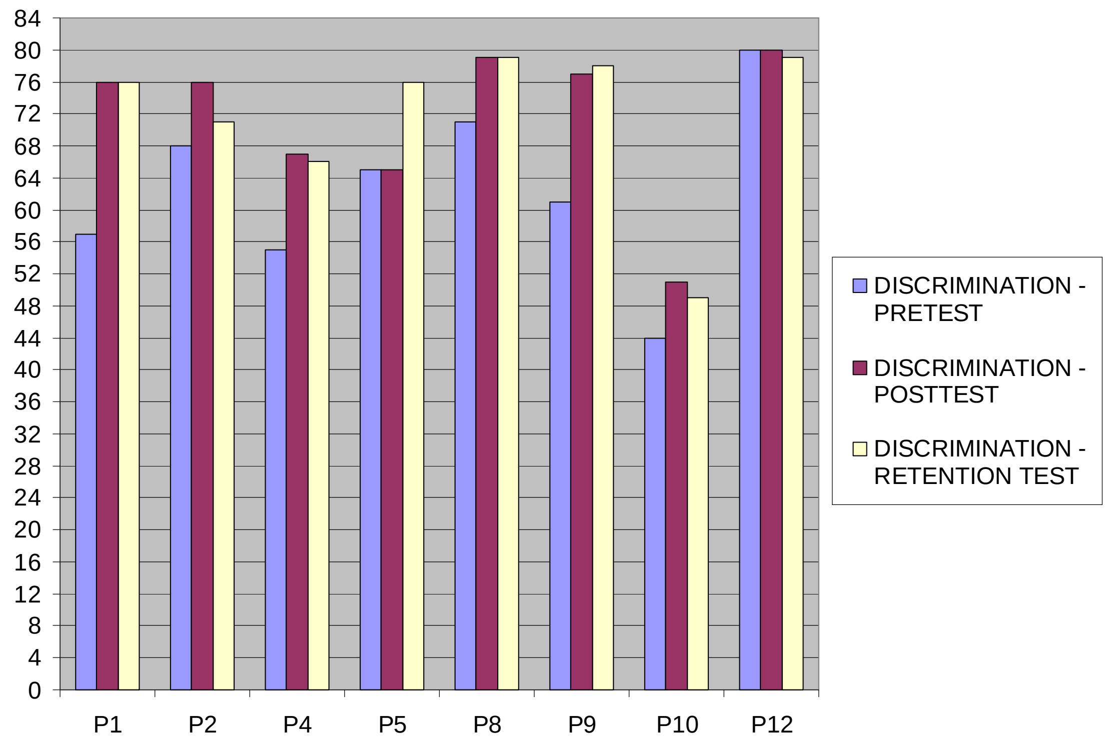


Figure 6.12 - Discrimination in the pre-, post, and retention tests

As in the case of identification, a Wilcoxon Signed Ranks Test yielded a positive difference between the pretest and the retention test, Z = 2.383, p = 0.17, and no significant difference between the posttest and the retention test, Z = .530, p = .596. Thus, the improvement acquired with training showed to be retained after eight months.

6.4.7.3 Retention in production

A considerable improvement in production was shown in the posttest, more precisely 22.92%. The use of the room for improvement was impressive as well – 81%. Figure 6.13 illustrates the retention of improvement in production in the eight-month follow-up test.

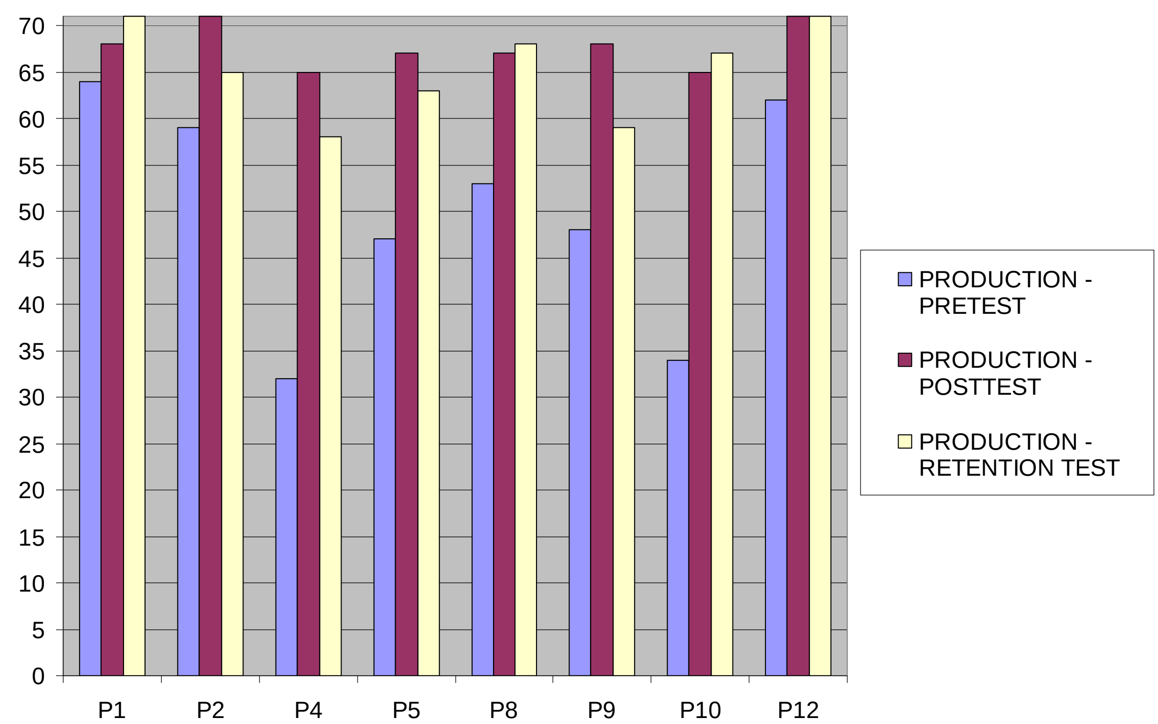


Figure 6.13 – Production in pre-, post- and retention tests

Wilcoxon Signed Ranks tests run on the pre- and retention tests – Z= 2.521, p = .012 – and on the post- and retention tests – Z = 1.352, p = .176 – indicated that the improvement was retained after eight months.

Table 6.22 displays the data obtained in the retention test through the interview.

Table 6.22 – Interview in the retention test

	[sp]			[st]			[sk]			[stɾ]		
	N	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**
P1	-	-	-	4	0	100%	-	-	-	1	0	100%
P2	-	-	-	3	0	100%	-	-	-	1	0	100%
P4	-	-	-	5	0	100%	-	-	-	-	-	-
P5	-	-	-	4	0	100%	-	-	-	1	0	100%
P8	1	0	100%	5	0	100%	-	-	-	-	-	-
P9	-	-	-	5	0	100%	-	-	-	2	0	100%
P10	-	-	-	4	0	100%	-	-	-	1	0	100%
P12	-	-	-	5	0	100%	-	-	-	1	0	100%
TOTAL	**1**	**0**	**100%**	**35**	**0**	**100%**	**-**	**-**	**-**	**7**	**0**	**100%**
	[sm]			[sn]			[sl]			[spɾ]		
	N	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**	**N**	**N of errors**	**Rate**
P1	1	0	100%	1	0	100%	2	0	100%	2	0	100%
P2	1	0	100%	-	-	-	2	0	100%	1	0	100%
P4	1	0	100%	1	0	100%	2	0	100%	1	0	100%
P5	1	0	100%	1	0	100%	3	[z]	67%	1	0	100%
P8	1	0	100%	1	0	100%	2	0	100%	1	0	100%
P9	1	0	100%	-	-	-	1	[z]	0%	1	0	100%
P10	1	0	100%	-	-	-	2	[z]	50%	-	-	-
P12	1	0	100%	1	0	100%	1	0	100%	1	0	100%
TOTAL	**8**	**0**	**100%**	**5**	**0**	**100%**	**15**	**3**	**80%**	**8**	**0**	**100%**

P1 voiced /sm/ in the posttest and showed improvement in the retention test by achieving 100% accuracy. P5 also voiced /sm/ in the posttest and did not voice /sm/ in the retention test. P5 had not produced /sl/ in the pre- and posttests, but produced two tokens of it in the retention test – one was accurate and the other was voiced. P9 produced voicing in combination with prothesis in /sl/, and voicing in /sm/ in the posttest and only voicing in /sl/ in the retention test. P2, P4, P8, P10, and P12 maintained 100% accuracy shown in the posttest. Therefore, all participants who had some room for improvement, improved from the posttest to the retention test, and the others maintained the perfect score.

To sum up, retention of improvement was detected in identification, discrimination and production, corroborating Hypothesis 4.6.

6.5 Participants comments and suggestions

All tests and training were personally administered by the researcher in individual sessions with the participants. As the training was given, all participants' comments, suggestions, and reactions – verbal and non-verbal – were noted down. This section presents some of their reactions, comments and suggestions regarding the tests design and the training program.

Participants' reactions

Participants varied greatly in their performance as well as in their reactions to the training. However, some patterns were noted. Most participants felt very confident and had a good performance in the first block of Session 1 of the training – identification (if stop vs. iffy stop). A few participants had difficulties from the first block on, but it was not the overall reaction. Most participants started having difficulty in the twenty-first block of Session 1 (move smiles vs. moves miles). At this point, two participants reacted, saying: "I will never get YOUR 93%... There is no difference!", and "are you really able to perceive the difference?". The latter participant, who was suspicious of my own ability to perceive the /s/ vs. /z/ contrast, apologized for that when he finally mastered the contrast and was, therefore, able to advance to the twenty-second block. Even during the "difficult times" the atmosphere was very pleasant and I managed to maintain a friendly relationship with the participants by always reinforcing that the contrasts were actually difficult, but important, and that everyone was able to learn them.

When the participant who said he would never be able to advance to Block 22 (actually, many of them said so) reached 93%, he asked me to repeat Block 21 so he could get 100%. This happened with more than one participant, in fact. One of the participants who repeated the block, thanked me at the end of the meeting, saying he had had a good time, and offered to invite friends to be participants of the study. Another participant thanked me for the opportunity to learn so much in such a short time, and a third one asked whether there was a possibility of taking the training task home to practice.

During the training, some participants got really annoyed at themselves for not being able to perceive the contrast, but I encouraged them to keep on by telling them that previous participants had taken longer and succeeded. A few participants mentioned that it seemed that when they were getting the contrast, they just had to start tuning it all again. Knowing that others had overcome the same problems seemed to motivate participants to try harder and not give up.

Some participants started to repeat out loud the stimuli heard and others repeated them silently. This indicated that they were trying to identify the contrast by articulating the sounds, that is, it might be taken as an interesting indication of the use of proprioceptive strategies in pronunciation learning in line with the direct realism approach. Many participants had difficulties with prothesis during training, but one participant (P4), in special, had difficulties with the prothesis contrast and no difficulty with the voicing contrast. All other fourteen participants found voicing a more difficult contrast than prothesis. And voicing was in fact the commonest error in production.

The only test which triggered comments from the participants was the AX discrimination test. Some participants complained that it was hard to remember the first stimuli to compare with the second because the two stimuli were similar and the activity was repetitive. In order to overcome the memory problem, in the retention test, P1 successfully imitated the first stimuli of each trial in the AX test and then was able to remember. This strategy was risky since she could have imitated the stimuli incorrectly. Other participants complained that the time (the intertrial interval) was too short to make a decision.

Participants' suggestions

Participants suggested the addition of two buttons on the screen, one for each of the stimuli of the block in question, so that they could repeat them as much as they wished till the contrast was mastered or just to remind them of the contrast in confusing moments during training.

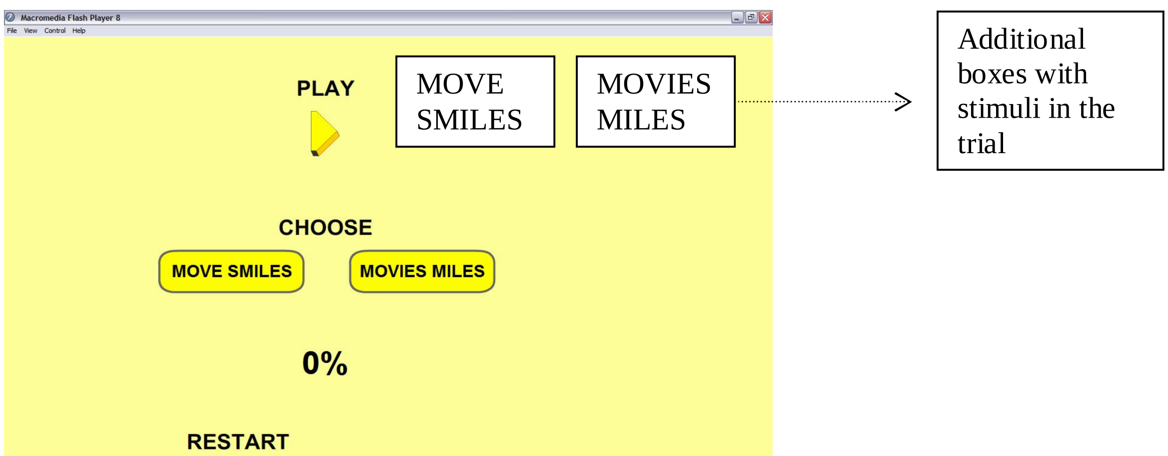


Figure 6.14 – Changes in the training as suggested by participants

6.6 Summary and further discussion of the results

The first question of this research was motivated by conflicting results of studies in Brazilian Portuguese/English interphonology about the influence of phonological context and cluster type in the production of word-initial /s/-clusters (Rebello, 1997; Rauber, 2002; Silveira, 2002; Cornelian, 2003; Rauber, 2006; Rebello & Baptista, 2006), and the lack of studies investigating such influence on perception. Data from the twenty-three participants of the present study were used to answer this question. Differently from previous studies (Rauber, 2006; Rebello & Baptista, 2006), phonological context did not significantly affect the production of word-initial /s/-clusters ($x^2 = 4.066$, $p = .254$) refuting **Hypothesis 1.1**. There was a tendency, however, for vowels to be the most difficult context and for voiced consonants to be more difficult than their voiceless counterparts, as in Cornelian (2003). The following hierarchy of difficulty was found from the most difficult to the easiest: Vowels (57%) > silence (61%) > voiced consonant (67%) > voiceless consonants (72%).

The clusters in violation of the sonority sequencing principle (/s/+stop clusters) were the clusters with the smallest number of misproductions (/s/+sonorants – accuracy rate of 45% vs. /s/+stops – accuracy rate of 84%; Z = 6.953, p = .000), thus, as in Cornelian (2003) - /s/+sonorants were more difficult than /s/+stops. No significant difference was found for cluster length, though (/sC/ – accuracy rate of 83%; /sCC/ – accuracy rate of 85%). **Hypothesis 1.2**, thus, was only partially corroborated and the results followed the same tendency found in Cornelian (2003) - /s/+sonorants (accuracy rate of 45%) were more difficult than /s/+stops.

Regarding effects of phonological context on perception, a tendency for vowels and voiced consonants to be the most difficult contexts was found, but failed to yield statistical significance (x^2 = 6.157, p = .104). The accuracy rate tendency found was voiced consonant (76.76%) < vowel (78.80%) < voiceless consonant (85.84%) < silence (90.57%). Thus, phonological context did not significantly affect perception either, and **Hypothesis 1.3** was refuted. The position of 'silence' in the hierarchy was the greatest contrast between perception and production – it was the easiest phonological context in perception and the second most difficult phonological context in production. Voiceless consonants, on the other hand, were among the easiest contexts in both domains.

The hierarchy proposed in Hypothesis 1.4 was that /s/+sonorant vs. modified /s/+sonorant clusters (e.g., /slip/ vs. /izlip/) were more difficult to discriminate than /s/+stop vs. modified /s/+stop clusters (e.g., /spik/ vs. /ispik/). The same hierarchy was found in the present study, but statistical tests failed to reach significance (Z = 1.859, p = .063). **Hypothesis 1.4** was not corroborated, but a tendency towards it was found. Other study might find that /s/+sonorant clusters are more difficult than /s/+stop clusters in perception as well as in production (H1.2).

To sum up, preceding phonological context seems not to affect perception and production of /s/-clusters. Cluster type, on the other hand, tends to affect both abilities. In this study, /s/+sonorant clusters were found to be more difficult than /s/+stop clusters in both domains. These similarities may be taken as an indication of the existence of a unified mechanism for perception and production in that both domains are affected by the same variables and to a similar extent.

The second question of this research was posed in order to investigate the relationship between identification and discrimination of word-initial /s/-clusters in

BP/English interphonology. When identifying a sound, one automatically compares and contrasts that sound with others. Thus, it is believed that discrimination has to happen for identification to occur and a relationship between the results of the identification and the AX discrimination test should exist. A strong correlation between identification and discrimination was actually found ($r(22) = .904$, $p = .000$) corroborating **Hypothesis 2.1**.

Concerning the effect of cluster type, in both identification and discriminations tests, the trials containing /st/ yielded more frequent accuracy than the trials containing /sl/. Statistical tests revealed a strong and very close to significance (*rho*= .949, p = .051) correlation between identification and discrimination by cluster type. Thus, a strong support for **Hypothesis 2.2** was found. The relationship between identification and discrimination was expected to reduce after training because the training program used an identification task, which would probably cause greater improvement in identification. In fact, the correlation found before training was nearly 80% ($r(14) = .891$, $p = .000$) and after training was 56% ($r(14) = .773$, $p = .001$) supporting **Hypothesis 2.3**.

The strong relationship found before training (80%) turned into a moderate relationship after training (56%). Improvement in the discrimination AX test was strongly affected by individual differences. The gain scores varied from 0% to 25%, and the proportion of the room for improvement varied from 0% to 95%. Some participants learned the contrast through the identification perceptual training and transferred this knowledge to the discrimination task; others, however, learned the contrast, but failed to have a similar gain in the discrimination task because had difficulties with the task per se. They reported not being able to hold the first stimuli of the trial in mind in order to discriminate it from the second stimuli and that the amount of time to make the decision was too short.

The third question inquired whether there would be a relationship between perception and production in BP/English interphonology. No generalization to production would be possible in case no relationship between perception and production were found before training. Statistical tests run on the data gathered in the pretest for the twenty-three participants yielded significant correlations between identification and the production in the reading tests ($r(22) = .864$, $p=.000$) and between discrimination and production in the reading tests ($r(22) = .818$, $p = .000$) corroborating **Hypothesis 3.1** and **Hypothesis 3.4**. The correlations found indicated that around 60% of what happened in production was related to perception.

Identification and production also correlated considering cluster type ($r(20) = .720$, $p = .000$) corroborating **Hypothesis 3.2**. In perception and production, /s/+sonorant clusters were more difficult than /s/+stop clusters and participants who had good scores in the identification test had fewer misproductions. Silveira (2002) also found a positive correlation between perception and production considering cluster type. The study assessed production through an oral translation task and perception through a discrimination test.

For the experimental group, there was a reduction in the correlation between identification and production after training (before training - $r(14) = .714$, $p = .003$, and after training - $r(14) = .614$, $p = .015$) as proposed in **Hypothesis 3.3**. However, considering only the story-reading task where participants tend to focus less on word-initial /s/-cluster pronunciation because there were other difficult and unknown words present, the relationship increased (before training - $r(14) = .174$, $p = .534$, and after training - $r(14) = .710$, $p = .003$). Considering the phrase-reading task (45 out of the 71 tokens of reading) where participants tended to focus all their efforts in correcting their articulation of word-initial /s/-clusters after training, there was a huge reduction in the correlation (before training - $r(14) = .750$ p = . 001, and after training – $r(14) = .329$, p = .231).

The ability to discriminate implies being able to accurately use cue-weighting strategies. Accurate cue-weighting is a necessary condition for accurate speech production in natural conditions. Therefore, it seems comprehensible that a stronger correlation between discrimination and production would be found before training when no intervention had been provided and participants were not aware of how they should monitor their speech. The correlation before training was weak, but significant ($r(14) = .591$, p = .020). After training, the correlation was weaker and barely significant ($r(14) = .515$, p = .049). Thus, the results corroborated **Hypothesis 3.5**.

The correlation between discrimination and production found for the twenty-three participants in the pretest was very significant and moderate ($r(22) = .818$, p = .000), but when only data from the fifteen participants of the experimental group were used, the correlation was significant but weak ($r(14) = .591$, p = .020). This is disturbing and calls attention to the power of individual differences. The results indicated a relationship between discrimination and production of around 64% for the twenty-three participants against nearly 35% for the experimental group. Even though the correlation is significant in both cases, the reduction was considerable. All in all, before and after training – participants who identified and discriminated better tended to produce word-initial /s/-clusters accurately more often and the relationship weakened after training.

The fourth question concerned the main objective of the present study. It was designed in order to investigate the effects of perceptual training on word-initial /s/-clusters. The question triggered six hypotheses. **Hypothesis 4.1** concerned improvement in the identification test from pretest to posttest. Results from statistical tests indicated that there was significant improvement in identification considering participants (Z= 3.298, p =.001) and considering phrases (Z = 3.367, p = .001). The participants' gain score in identification was 8.41% corresponding to a proportion of 59% of the room for improvement. Since stimuli recorded by the main talker in the identification test were not included in the training, the improvement in identification can indicate generalization to an unfamiliar talker in line with Bettoni-Techio & Koerich (2008).

The investigation of **Hypothesis 4.2** which concerned transfer of improvement to discrimination was also corroborated as expected from the significant positive correlation (*r*(22) = .904, p = .000) found within the domain of perception during the investigation of the second question. The mean gain was 12.62% and corresponded to a proportion of 50% of the room for improvement. The identification training was successful in changing participants' cue-weighting; that is, they started focusing on cues which were not relevant before training.

Hypothesis 4.3 concerned transfer of improvement to production. Improvement in production was obtained in several previous studies (e.g., Rochet, 1995; Bradlow et al, 1997; Lambacher et al, 2005; Bettoni-Techio & Koerich, 2008). The results of the present study indicated that there was transfer of improvement in the overall production of the participants (Z = 3.297, p =.001) as well as for each task individually. The overall gain score was 22.92% corresponding to 81% of the room for improvement. The greatest improvement was in the phrase-reading test (Z = 3.300, p = .001) where participants were more able to control their production followed by the paragraph-reading task (Z = 3.201, p = .001) and then by the story-reading task (Z = 2.810, p = .005).

The greatest improvement in the most formal task may indicate that awareness was an important factor for the improvement in production because it triggered the use of monitoring strategies. A qualitative analysis of the interviews revealed that /s/+sonorant clusters were more frequently modified in the pre- and posttests and that voicing was the most frequent error in both phases as well. A reduction in errors could be observed from pre- to posttest.

In the reading tests, a reduction of errors was observed as well. The greatest amount of reduction was found for voicing (Z = 3.300, p = .001), against **Hypothesis 4.4** which proposed that there would be a higher reduction in the occurrences of prothesis than of voicing. Wilcoxon Signed Ranks tests yielded significant reductions in prothesis, Z = 2.823, p = .005, and in prothesis+voicing, Z = 2.937, p = .003, as well. In the pretest, voicing was three times more frequent than prothesis even though only /s/+sonorant clusters were susceptible to voicing and all cluster types were susceptible to prothesis. The great number of voicing occurrences in the pretest allowed for a larger room for improvement and thus the gain scores for voicing were much higher than for prothesis. In the posttest, three out of ten participants who produced prothesis in the pretest remained producing prothesis and eleven out of fourteen participants who produced voicing remained producing voicing.

Hypothesis 4.5 proposed that there would be generalization of improvement to untrained clusters. Statistical tests showed that, in line with Bettoni-Techio and Koerich (2008), there was a generalization of improvement to untrained clusters in identification - 7% gain, corresponding to 55% of the room for improvement, and in production – 23% gain, corresponding to 66% of the room for improvement. Also, there was no difference between the improvement in trained and untrained clusters in the identification task (Z = .861, p = .389), and in production (Z = .227, p = .820) corroborating the hypothesis.

Finally, **Hypothesis 4.6** proposed that the improvement found in the posttest would be found in a follow-up test eight months after the posttest. Statistical tests run on post- vs. retention test scores in identification (Z = .848, p = 396), discrimination (Z = .530, p = .596), and production (Z = 1.352, p = .176) indicated that there was no difference in performance between posttest and retention test. Thus, there was retention of improvement in all tests corroborating Hypothesis 4.6. Retention of improvement was found within shorter intervals in previous studies (e.g., within one month in Nobre-Oliveira, 2007; within five months in Bettoni-Techio & Koerich, 2008; within three and six months in Lively et al, 1994).

Final remarks, limitations of the study, suggestions for further studies and pedagogical implications drawn from the results presented here are discussed in Chapter 7.

CHAPTER 7

CONCLUSION

7.1 Final remarks

The main objective of the study was to investigate effects of perceptual training on the pronunciation of word-initial /s/-clusters in the BP/English interphonology. Four research questions were addressed. Question 1 investigated the influence of phonological context and cluster type on the production and perception of word-initial /s/-clusters. Question 2 explored the relationship between two perception tasks – identification and discrimination, and question 3 explored the relationship between perception and production, by perception task, and by clusters. Finally, question 4 examined the effects of a perceptual training program on word-initial /s/-clusters, specially designed for the experiment.

Specifically, the study investigated (a) the effects of phonological context (vowels vs. consonants vs. silence), and of cluster type (/s/-stops vs. /s/-sonorants) on the perception and production (H1.1, H1.2, H1.3, H1.4), and the effects of length (/sC/ vs. /sCC/) on the production of these clusters (H1.2); (b) the relationship before and after training between the two perception tasks used as data gathering tools – identification and discrimination (H2.1, H2.1, H2.3); (c) the relationship between perception and production, by perception task (H3.1, H3.4), the relationship between identification and production by cluster (H3.2), between identification and production, and discrimination and production before and after training (H3.3, H3.5), and finally, (d) the effects of a perceptual training program using an identification task, hypothesizing that, from the pre-test to the posttest administered just after the training, and to the retention test administered 8 months after training, there would be improvement in the identification performance (H4.1, H4.6), and that this improvement would generalize to the untrained perception task – discrimination (H4.2, H4.6), to untrained clusters (H4.5), and to production (H4.3, H4.6). Concerning production, a further hypothesis proposed that voicing would be a more persistent error than prothesis (H4.4).

Concerning the first question, phonological context did not significantly affect error rate in perception or in production. However, as in Cornelian (2003), a tendency was found for vowels and voiced consonants as preceding contexts of /s/-clusters to be more difficult than voiceless consonants. Also as in Cornelian's study, no significant difference was found for cluster length – participants mispronounced the /sC/ clusters as frequently as the /sCC/. On the other hand, regarding the constituents of the clusters, /s/+sonorant clusters were significantly more difficult than /s/+stop clusters, both in perception and in production, corroborating Cornelian (2003), Rauber (2002, 2006), and Rebello and Baptista (2006).

Concerning the second and third questions, the results obtained in the present study seem to indicate that the relationship within the perception domain is stronger than the relationship across domains. It seems to be obvious that some level of discrimination is involved in identification tasks. Thus, discrimination and identification seem to be interdependent. Improvement in identification and generalization of improvement to discrimination, as well as to production was found in the posttest, and in the eight-month retention test. The relationship between perception and production was studied comparing identification and production and discrimination and production. As in Silveira (2002), the relationship was examined by participant and by cluster type.

Participants improved differently in the different tasks changing the correlation scores yielded by Spearman's Rank Order Correlation tests. For instance, nearly all participants had a close to perfect score on the phrase-reading posttest where more control was allowed and monitoring strategies took place. Before the intervention of the training program, the correlations between perception and production were stronger and more significant. Following the training, these correlations changed to weaker and/or insignificant indicating that the participants started to rely on cues that were ignored before training. The overall results indicate that there may be a common mechanism for perception and production, since both domains are affected by the same variables and to a similar extent.

Overall, training of /s/-clusters caused positive changes in perception, since there was consistent improvement in the identification and in the discrimination tasks, and in production, since there was improvement in the reading tasks and in the interview for trained and untrained clusters. Results of posttest and of the retention test may serve as evidence that adults are able to learn new sounds through massive exposure to the target language and immediate feedback – the strategies used in the training program.

7.2 Limitations and suggestions for further research

Several limitations have appeared in the present study, and their identification and suggestions to overcome them are crucial for future research. The first limitation concerns the number of participants. The small number of participants involved in the first phase of the study – the pre-test, the training and the posttest, resulted in an even smaller number of participants in the 8-month retention test. Future studies could replicate the present one with a larger sample. Also, in relation to the number of participants, the control group and the experimental group should have the same number of participants.

Besides a control and an experimental group, a third group could be added in a follow-up project. The third group would receive instruction (metalanguage) about the pronunciation of word-initial /s/-clusters, but have no training per se. Or, yet, a fourth group undertaking training and receiving instruction concomitantly could be added. In such projects, it would be possible to investigate the effect of awareness raising about 'the rule' on pronunciation mastering. Studies in this line of investigation would contribute to the discussion about the role of declarative knowledge vs. procedural knowledge in pronunciation learning.

Regarding data-gathering instruments, the interview task elicited very few tokens, especially of /sp/ and /sk/. More questions should be added so that more tokens would be produced. Other instruments such as periodical production and perception tests should be developed and implemented to track participants' progress throughout the training program.

Also, most participants did not entirely use their room for improvement. The perceptual training program could be administered a second time in order to verify whether additional training could promote further improvement or whether the maximal improvement level had been reached in a specific moment in the first administration of the training program.

7.3 Pedagogical implications

The results from the perceptual training program show that it is a good tool for enhancing learning of word-initial /s/-clusters. These results, along with results from the studies reviewed here indicate that identification and production of several non-native sounds can be improved with the help of training with the benefit of computers. In such programs, teachers participate indicating what errors learners should focus on and how to use the tool. In general, perceptual training materials are simpler to use than speech recognition software and they seem to be a very good option for self-study and for teaching pronunciation in distance learning courses.

Ideally, the training would be administered in a lab where there was one machine for each student, and students could set their own pace in the activities. The software should register the number of repetitions of each stimulus, trial, or block and all the other pertinent data. Students should, then, receive special assistance in their specific problems. Another possibility is to devise training programs to be run on the students' own PCs.

The experience in the individual sessions of the training administered in the present study showed that it is important to provide encouragement so that students do not give up when they face the first difficulties. When the teacher is not present, the words of encouragement should be given in written or oral form in the software. Also, it is important to provide instructions and feedback during the training. Constant feedback from the teacher or from the software on the quality of learners' performance may cause changes in the long run.

REFERENCES

Baptista, B. O. (2004). Categorias fonéticas na aprendizagem de língua estrangeira. *Revista de Estudos da Linguagem*, 12/2, 475-489.

Baptista, B. O. (2006). Adult phonetic learning of a second language vowel system. In B. O. Baptista & M. Watkins (Eds.), *English with a latin beat: Studies in Portuguese/Spanish – English Interphonology*. (pp. 19-40). Amsterdam: John Benjamins Publishing.

Baptista, B. O. & Silva Filho, J. L. A. (2006). The influence of voicing and sonority relationships on the production of English consonants. In B. O. Baptista & M. Watkins (Eds.), *English with a latin beat* (pp. 73-90). Amsterdam: John Benjamins Publishing.

Beddor, P. S., Harnsberger, J. D., Lindeman, S. (2002). "Language-specific patterns of vowel-to-vowel coarticulation: Acoustic structures and their perceptual correlates." Journal of Phonetics 30: 591-627.

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 171-206). Timonium: York Press.

Best, C.T., & Tyler, M.D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In O.-S. Bohn & M.J. Munro (eds) *Language Experience in Second language Speech Learning. In honor of James Emil Flege* Amsterdam: John Benjamins (Series: Language Learning and Language Teaching). Chapter 2, 13-34.

Bettoni-Techio, M. (2005). *Production of final alveolar stops in Brazilian Portuguese/English interphonology*. Unpublished master thesis. Federal University of Santa Catarina.

Bettoni-Techio, M. & Koerich, R. D. (2006). Palatalization in Brazilian Portuguese/English interphonology. *Revista Virtual de Estudos da Linguagem – ReVEL*. Ano 4, n. 7, [http://paginas.terra.com.br/educacao/revel/].

Bettoni-Techio, M. (2006). *Effects of perceptual training on /s/-cluster pronunciation*. Unpublished monograph. Federal University of Santa Catarina.

Bettoni-Techio, M. (2008). *Perceptual training and word-initial /s/-clusters*. Unpublished monograph. Federal University of Santa Catarina.

Bettoni-Techio. M. & Koerich, R. D. (2008). Perceptual training on the pronunciation of /s/-clusters in Brazilian Portuguese/English In Rauber, A. S., Watkins, M.A., & Baptista, B. O. (Eds.): New Sounds 2007: Proceedings of the Fifth International Symposium on the Acquisition of Second Language Speech Florianópolis, Brazil: Graduate Program in English, Federal University of Santa Catarina p. 53-66

Bettoni-Techio, M.; Rauber, A. S.; Koerich, R. D.. (2007). Perception and Production of Word-Final Alveolar Stops by Brazilian Portuguese Learners of English. In: Interspeech 2007 - Antwerp, Bélgica.

Bonilha, G. F. G.; Vinhas, L. I. (2005). Aquisição de onsets complexos: militância da hierarquia de restrições da língua materna. *Revista Virtual de Estudos da Linguagem – ReVEL*. Ano 3, n. 5. [www.revelhp.cjb.net]

Bradlow, A. R., Pisoni, D. B., Akahane-Yamada, R. & Tohkura,Y. (1997). Training Japanese listeners to identify English /r/ and /l/: IV. Some effects of perceptual learning on speech production. *Journal of the Acoustical Society of America 101 (4), pp. (2299 – 2310).*

Bradlow, A. R., Akahane-Yamada, R., Pisoni, D. B., & Tohkura, Y. (1999). Training Japanese listeners to identify English /r/and /l/: Long-term retention of learning in perception and production *Perception & Psychophysics, 61 (5), 977-985* .]

Callan, D., Tajima, K., Callan, A., Kubo, R., Masaki, S. and Akahane-Yamada, R. (2003). Learning-induced neural plasticity associated with improved identification performance after training of a difficult second-languaege phonetic contrast. *Nature NeuroImage, 19,*113-124.

Carlisle, R. S. (1991). The influence of environment on vowel epenthesis in Spanish/English interphonology. *Applied Linguistics, 12(1),* 77-95.

Carlisle, R.S. (1992). Environment and markedness as interacting constraints on vowel epenthesis. A. James & J. Leather (Eds.) New Sounds 92: Proceedings of the Third International Symposium on the Acquisition of Second-language Speech, Klagenfurt, Austria: University of Klagenfurt, p. 64-75.

Carlisle, R.S. (1994). Markedness and environment as internal constraints on the variability of interlanguage phonology. In M. Yavas (Ed.), First and second language phonology (pp. 223-249). San Diego: Singular.

Carlisle, R. S. (1997). The modification of onsets in a markedness relationship: Testing the interlanguage structural conformity hypothesis. *Language learning,* 47, 327-361.

Carlisle, R.S. (1998). The acquisition of onsets in a markedness relationship: a longitudinal study. *Studies in Second Language Acquisition*, 20, p. 245-260.

Carlisle, R. S. (2001). The acquisition of onsets in a markedness relationship: The results of a five year longitudinal study. *Paper Presented at the AAAl Annual Conference 2001, St. Louis, MO.*

Carlisle, R. S. (2006). Production of English initial /s/-clusters by speakers of Brazilian Portuguese and Argentinean Spanish. In B. O. Baptista & M. Watkins (Eds.), *English with a latin beat* (pp. 155-167). Amsterdam: John Benjamins Publishing.

Cornelian, D. (2003). *Brazilian Learners' Production of Initial /s/ Clusters: Phonological Structure and Environment.* Unpublished master thesis. Federal University of Santa Catarina.

Ellis, N. (2005). At the interface: dynamic interactions of explicit and implicit language knowledge. *Studies in Second Language Acquisition,*27, 305-352.

Flege, J. E. (1987). Effects of equivalence classification on the production of foreign language speech sounds. In: James, A. & Leather, J. (Eds.). *Sound Patterns in Second Language Acquisition*. Dordrecht: Foris Publications, 47-65.

Flege, J. E. (1988). Factors affecting degree of perceived foreign accent in English sentences. *Journal of the Acoustical Society of America, 84(1),* 70-79.

Flege, J. E. (1989). Chinese subjects' perception of the word-final English /t/-/d/ contrast:. performance before and after training. *The Journal of the Acoustical Society of America,* 86, (5), 1684-1697.

Flege, J. E. (1995). Second Language speech learning: theory, findings, and problems. In W. Strange (Ed.), *Speech Perception and linguistic experience: Issues in cross-language research*. Timonium, MD: York Press, 233-272.

Flege, J. E. (1996). English vowel production by Dutch talkers: More evidence for the "similar" vs "new" distinction. In A. James & J. Leather (Eds.), Second-language speech: Structure and process (pp. 11-52). Berlin: Moulton de Gruyer.

Flege, J. E. (1997). The role of phonetic category formation in second-language speech learning. *Paper presented at the New Sounds 97: Proceedings of the third international symposium on the acquisition of second language speech*, Klagenfurt, Austria.

Flege, J. & MacKay, I. (2004) Perceiving vowels in a second language. Studies in Second Language Acquisition.26, 1-34.

Flege, J. E., Munro, M. J. & MacKay, I. R. A. (1996). *Factors Affecting the Production of Word-initial Consonants in a Second Language*. In Second Language Acquisition and Linguistic Variation, Bayley, Robert and Dennis R. Preston (eds.), 47 ff.

Flege, J. E., Munro, M. J., & Fox, R. A. (1994). Auditory and categorical effects on cross-language vowel perception. Journal of the Acoustical Society of America, 95(6), 3623-3641.

Fowler, C. A. (1986). An event approach to the study of speech perception from a direct-realist perspective. *Journal of Phonetics* 14. 3-28.

Gallardo del Puerto, F., Lecumberri, M. L. G. & Cenoz, J.(2006). Age and native language influence on the perception of English vowels. . In B. O. Baptista & M. Watkins (Eds.), *English with a latin beat - Studies in Portuguese/Spanish – English Interphonology* (pp. 57-69). Amsterdam: John Benjamins Publishing.

Gass, S. (1996). Second Language Acquisition and Linguistic Theory: The Role of Language Transfer. In Ritchie, W. C. and Bhatia, T. K. (Ed) *Handbook of Second Language Acquisition*.U.S.A.: Academic Press. pp. 317-348.

Guion, S., Flege, J. E., Akahane-Yamada, R., & Pruitt, J. (2000).An investigation of current model of second language speech perception: The case of Japanese adults' perception of English consonants. *Journal of the acoustical society of America,* 107 (5), 2711-2724.

Guion, S. & Pederson, E. (2007). Investigating the role of attention in phonetic learning. In O.-S. Bohn & M. Munro (Eds.) *Second-language speech learning: The role of language experience in speech perception and production: A festschrift in honour of James Emil Flege*. (pp. 57-77)Amsterdam: John Benjamins.

Hallé, P., Segui, J. Frauenfelder, U.H. & Meunier, C. (1998). The processing of illegal consonant clusters: A case of perceptual assimilation? *Journal of Experimental Psychology: Human Perception and Performance*, 24 (2),592-608.

Hancin-Bhatt, B. (1994). Segment transfer: A consequence of a dynamic system. *Second Language Research*, *10*, 241–269.

Hancin-Bhatt, B. (1997). Extended full transfer/full access in L2 sound patterns: a prolegomena. In Leather, J. and James, A., editors, *NewSounds '97: Proceedings of the Third International Symposium on the Acquisition of Second-Language Speech*. Klagenfurt: University of Klagenfurt, 109–117.

Hardison, D. (2000). Transfer of second-language perceptual training to production improvement: focus on /r/ and /l/. In: James, A. & Leather, J., eds., New Sounds 2000: Proceedings of the Fourth International Symposium on the Acquisition of Second-Language Speech. University of Klagenfurt, 166-173.

Hardison, D. (2003). Acquisition of second-language speech: Effects of visual cues, context, and talker variability. *Applied Psycholinguistics, 24*, 495-522.

Hardison, D. (2004). Generalization of computer-assisted prosody training Quantitative and qualitative findings. *Language Learning & Technology, 8,* 34-52.

Hardison, D. (2005). Second-language spoken word identification: Effects of perceptual training, visual cues, and phonetic environment. *Applied Psycholinguistics, 26,* 579-596.

Harnsberger, J.D. (2000). A cross-language study of the identification of non-native nasal consonants varying in place of articulation. *Journal of the Acoustical Society of America*, 108, 764-783.

Harnsberger, J. (2001). On the relationship between identification and discrimination of non-native nasal consonants. *Journal of the acoustical society of America,* 110 (1), 489-503.

Hazan, V., Sennema, A., Iba, M. & Faulkner, A. (2005) Effect of audiovisual perceptual training on the perception and production of consonants in Japanese learners of English, *Speech Communication*, 47, 360-378.

Iverson, P., Hazan, V., & Bannister, K. (2005) Phonetic training with acoustic cue manipulations: A comparison of methods for teaching English /r/-/l/ to Japanese adults, *Journal of the Acoustical Society of America*, 118, 3267-3278.

Jamieson, D. G. & Morosan, D. E. (1986). Training nonnative speech conrasts in adults: Acquisition of the English /ð/ -/θ/ contrast by francophones. *Perception and Psychophysics, 40 (4),* 205-215.

Jusczyk, P. W., Hohne, E. A, & Mandel D. R. (1995). Picking up regularities in the sound structure of the native language. In W. Strange (Ed.), *Speech perception and linguisticexperience: Issues cross-language research* (pp. 91-119). Timonium, MD: York Press.

Kabak, B. & Idsardi, W. J. (2007). Perceptual Distortions in the Adaptation of English Consonant Clusters: Syllable Structure or Consonantal Contact Constraints? *Language and Speech,* 50, 1 pp. 23-52

Kluge, D. (2004). Perception and production of final nasals by Brazilian Portuguese learners of English. Unpublished master thesis, Universidade Federal de Santa Catarina, Florianópolis.

Koerich, R. D. (2002). Perception and production of word-final vowel epenthesis by Brazilian EFL students. Unpublished doctoral dissertation. Universidade Federal de Santa Catarina.

Koerich, R. D. (2006). Perception and production of vowel paragoge by Brazilian EFL students. In B. O. Baptista & M. A. Watkins (Eds.), *English with a Latin Beat: Studies in Portuguese/Spanish – English Interphonology* (pp. 91-104). Amsterdam: John Benjamins.

Lambacher, S. G., Martens, W. L., Kakehi, K., Marasinghe, C. A., & Molholt, G. (2005). The effects of identification training on the identification and production of American English vowels by native speakers of Japanese. *Applied Psycholinguistics, 26,* 227-247.

Leather, J. & James, A. (1996). Second Language Speech. In W. C. Ritchie and T. K. Bhatia (Eds.) *Handbook of Second Language Acquisition* (pp. 269-316). San Diego, California: Academic Press.

Liberman A M, Cooper F S, Shankweiler D P & Studdert-Kennedy M. (1967). Perception of the speech code. *Psychological. Review.* 74, 431-61.

Lively, S. E., Logan, J. S.. & Pisoni, D. S. (1993). Training Japanese listeners to identify English /r/ and /l/. II: The role of phonetic environment and talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America, 94,* 1242-1255.

Lively, S. E., Logan, J. S.. & Pisoni, D. S. (1994). Training Japanese listeners to identify English /r/ and /l/. III: long-term retention of new phonetic categories. *Journal of the Acoustical Society of America, 96,* 2076-2087.

Logan, J. S., Lively, S. E., & Pisoni, D. S. (1991). Training Japanese listeners to identify English /r/ and /l/: a first report. *Journal of the Acoustical Society of America, 89,* 874-886.

Major, R.C. (1986). The natural phonology of second language acquisition. In A. James & J. Leather (Eds.) Sounds Patterns in Second Language Acquisition (pp. 207-224). Dordrecht: Foris.

Major, R. C. (1992). Transfer and developmental factors in second language acquisition of consonant clusters. Paper presented at the New Sounds 92: Proceedings of the 1992 Amsterdam symposium on the acquisition of second-language speech, Amsterdam, Holland.

Major, R.C. (1996). Markedness in second language acquisition of consonant clusters. *Studies in Bilingualism,* 10, 75-96.

Major, R.C. (1998). Interlanguage Phonetics and Phonology – An Introduction. *Studies in Second Language Acquisition, 20,* 131-137.

Massaro, D.W. (1998). *Perceiving talking faces: From speech perception to a behavioral principle.* Cambridge, Mass: MIT Press.

McLeod, S., Sturt, C., & Bleile, K.. (2003). Neurological and developmental foundations of speech acquisition – A summary: brain development and the environment. In Proceedings of the American speech-language-hearing association convention 2003. Chicago.

Nobre-Oliveira, D. (2007). *The effect of perceptual training on the learning of English vowels by Brazilian Portuguese speakers*. Unpublished Doctoral Disseration. Federal University of Santa Catarina.

Pisoni, D. B., & Tash, J. (1974). Reaction times to comparisons within and across phonetic categories. Perception & Psychophysics, 15, 285-290.

Piza, A. T. V. (2007). Perception and production of English final stops by young Brazilian EFL students. Unpublished master thesis. Universidade Federal de Santa Catarina.

Pruitt, J. S., Jenkins, J.J., & Strange, W. (2006). Training the perception of Hindi dental and retroflex stops by native speakers of American English and Japanese. *Journal of the Acoustical Society of America 119 (3)*, 1684 – 1696.

Rauber, A. S. (2002). *The Production of English Initial /s/ Clusters by Portuguese and Spanish EFL Speakers*. Unpublished master thesis. Universidade Federal de Santa Catarina: Florianópolis.

Rauber, A. S. (2006). Production of English initial /s/-clusters by speakers of Brazilian Portuguese and Argentine Spanish. In B. O. Baptista & M. A. Watkins. *English with a Latin Beat: Studies in Portuguese/Spanish – English Interphonology* (pp. 155-167). Amsterdam: John Benjamins.

Rebello, J. T. & Baptista, B. O. (2006). The influence of voicing on the production initial /s/-clusters by Brazilian learners. In B. O. Baptista & M. A. Watkins. *English with a Latin Beat: Studies in Portuguese/Spanish – English Interphonology* (pp. 139-154). Amsterdam: John Benjamins.

Rebello, J. T. (1997). The acquisition of initial /s/ clusters by Brazilian EFL learners. In J. Leather & A. James (Eds.) *New Sounds 97: Proceedings of the third international symposium on the acquisition of second-language speech* (pp. 336-350). Klagenfurt: University of Klagenfurt.

Reis, M. S. (2006). the perception and production of English interdental fricatives by Brazilian EFL learners. Unpublished master's thesis: Universidade Federal de Santa Catarina.

Rochet, B. L. (1995). Perception and production of second-language speech sounds by adults. In W. Strange (Ed.) *Speech perception and linguistic experience: Issues in cross-language research*. Timonium: York Press, 379-410.

Sebastián-Galles, N. (2005). Cross-Language Speech Perception. In In D.B. Pisoni & R.E. Remez (Eds.), *Handbook of Speech Perception*. pp. 546–566. Blackwell Publishers.

Silveira, R. (2002). Perception and production of English initial /s/clusters by Brazilian learners. *Revista brasileira de lingüística aplicada, Vol.2, n1*, 95-119.

Silveira, R. (2004). *The influence of pronunciation instruction on the perception and production of English word-final consonants*. Unpublished doctoral dissertation, Universidade Federal de Santa Catarina, Florianópolis.

Souza, A. C. (1998). *Estrutura do português brasileiro e do inglês americano: Estudo comparativo*. Unpublished master's thesis, Universidade Federal de Santa Catarina, Florianópolis. 1998.

Spolsky, N. (1989). *Conditions for Second Language Learning*. Oxford University Press.

Strange, W. (1992). Learning non-native phoneme contrasts: Interaction among subject, stimulus and task variables. In Y. Tohkura, E. Vatikiotis-Bateson, & Y. Sagisaka (Eds.), Speech perception, production and linguistic structure (pp. 197–219). Tokyo, Japan: Ohmsha.

Strange, W. (1995). Cross-language studies of speech perception: A historical view. In W. Strange (Ed.), Speech perception and linguistic experience: Issues in cross-language research (pp.3-45). Timonium, MD: York Press.

Strange, W. & Dittmann, S. (1984). Effects of discrimination training on the perception of /r-l/ by Japanese adults learning English. *Perception & Psychophysics, 36* (2), 131-145.

Tarone, E. (1987). Some Influences on the syllable structure of interlanguage phonology. In G. Ioup &S.H. Weinberer (Eds.), *Interlanguage Phonology: the acquisition of a second_language sound system_*(pp.232-247). New York: Newbury House.

Trapp, N. L., and Bohn, O. S. (2000). Training Danish listeners to identify English word-final /s/ and /z/: Generalization of training and its effect on production accuracy. In: James, A. & Leather, J., eds., New Sounds 2000: Proceedings of the Fourth International Symposium on the Acquisition of Second-Language Speech. University of Klagenfurt, 343-350.

Wang, Y., Spence, M. M., Jongamn, A., & Sereno, J. (1999).Training American listeners to perceive Mandarin tones. *Journal of the Acoustical Society of America*, 106 (6) pp. 3649-3658.

Wang, X., & Munro, M. (2004). Computer-based training for learning English vowel contrasts. *System, 32*, 539-552.

Watkins, M. (2001). Variability in vowel reduction by Brazilian speakers of English, Unpublished doctoral dissertation. Universidade Federal de Santa Catarina.

Wayland, R. (2007). The relationship between identification and discrimination in cross-language perception: The case of Korean and Thai. In O.-S. Bohn & M. Munro (Eds.) *Second-language speech learning: The role of language experience in speech perception and production: A festschrift in honour of James Emil Flege*. (pp. 301-314)Amsterdam: John Benjamins.

Wayland, R. P. & Guion, S. G. (2004). Training English and Chinese listeners to perceive Thai tones: A preliminary report. *Language Learning* 54, 681-712.

Wayland, R. P. & Li, B. (2008). Effects of two training procedures in cross-language perception of tones. *Journal of Phonetics*, 36, 250-267.

Werker, J. and Logan, J. (1985). Cross-language evidence for three factors in speech perception. *Perception & Psychophysics* 37, 35–44.

Yeon, S. (2004) *Teaching English word-final alveolopalatals to native speakers of Korean*. Unpublished doctoral dissertation. University of Florida.

Yildiz, Y. (2005). The structure of initial /s/-clusters: evidence from L1 and L2 Acquisition. In Marina Tzakosta, Claartje Levelt & Jeroen van der Weijer (eds.), Developmental Paths in Phonological Acquisition. Special issue of Leiden Papers in Linguistics, pp.163-187.

APPENDICES

Appendix A – Background Questionnaire

Universidade Federal de Santa Catarina

Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Pesquisadora: Melissa Bettoni-Techio
Orientadora: Profª Drª Rosana Denise Koerich
DATA : __________/_________________/_______________

N:

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 pesquisadora acima citada. Em nenhuma hipótese os nomes dos participantes serão divulgados. Solicito informar nome e telefone somente para, no caso de necessitar alguma informação adicional, poder entrar em contato com você posteriormente.

1. NOME:____

3. DATA DE NASCIMENTO:______________/_________________/____________

4. SEXO: FEM / MASC 5. TEL: __________________________________

6. E-MAIL: ____

7. PROFISSÃO: ____

8. (PARA ESTUDANTES) CURSO: ______________________ FASE: ___________

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.

9. Fez inglês no colégio? SIM / NÃO

10. Desde que série?

11. Qual sua idade na época?

12 As aulas exploravam comunicação escrita e oral?

13. Fez curso de inglês? SIM / NÃO

14. Qual curso/escola?

15. Em que ano começou?

16. Em que ano terminou/parou?

17. Quantas horas por semana tinha o curso em média?

18. Qual o curso de inglês que freqüenta no momento?_______________________

19. Qual nível/semestre/fase que freqüenta no momento?

20. Quantas horas semanais têm este curso?

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

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

23. Por quanto tempo? 24. Qual sua idade na época?

25. Freqüentou escola naquele país? SIM / NÃO
26. Que tipo de escola/ curso?
27. Conversa com freqüência em inglês com outros brasileiros? SIM / NÃO
28. Conversa com freqüência em inglês com falantes nativos? SIM / NÃO
29. Assiste filmes sem dublagem com freqüência? SIM / NÃO
30. Ouve música em inglês com freqüência? SIM / NÃO
31. Canta? SIM / NÃO
32. Transcreve (tira) letras de músicas? SIM / NÃO
33. Estuda, estudou, ou tem contato com outra língua estrangeira? SIM / NÃO
34. Em que contexto? (escola, na família...)
35. Qual língua?
36. Em que cidade foi criado/a?
37. Acrescente qualquer informação que julgar interessante

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literaturas Correspondentes
Researcher: Melissa Bettoni-Techio
Adviser: Prof[a] Dr[a] Rosana Denise Koerich

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 classes a week, on the average were devoted to the course?
15. What English course are you presently taking?
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 B - Production in Brazilian Portuguese

1. Ela comprou um colar de esmeraldas.
2. Foi um dia muito especial.
3. Você é muito esperto.
4. Joana é muito estranha e misteriosa.
5. A esperança é a última que morre.
6. Quem espera sempre alcança.
7. Estava escrito nas estrelas.
8. Eu comi um chocolate diferente.
9. Eu te admiro muito.

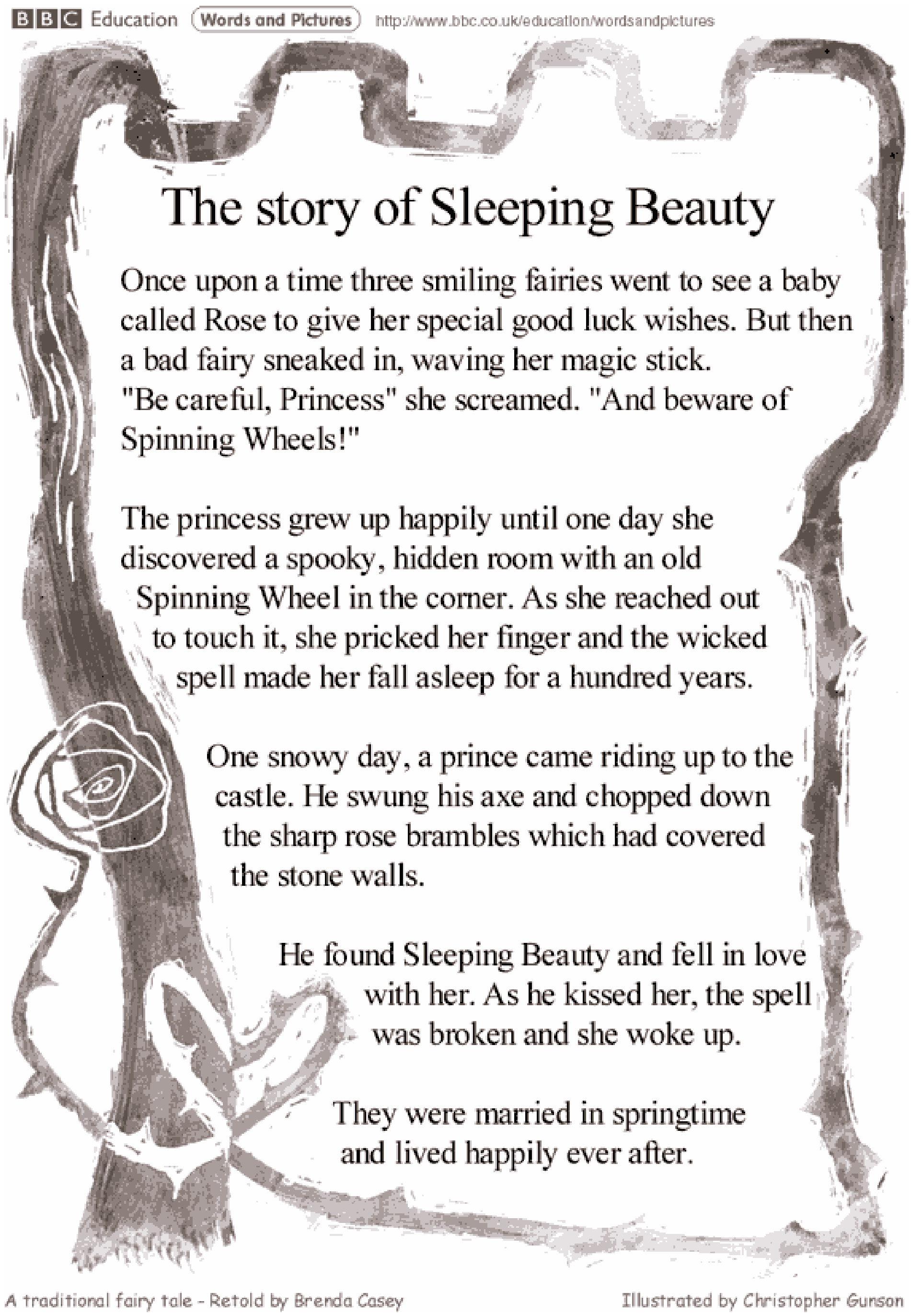
Appendix C - Possible questions for the interview

1- What should a driver do when the traffic light is red? (stop)
2- Tell me about your last vacation. (stay, spend)
3- What do you look for in a friend? (special)
4- What is your occupation? What do you do? (study/student)
5- What do you see yourself doing within five years?
6- What are the four seasons of the year? (spring, summer, fall/autumn, winter)
7- What is your favorite season and why?
8- What is the name of the actor who was RAMBO/Rocky? (Stallone) Describe him (strong…)
9- What can you find in a kitchen? (stove, spoons…)
10- What can we see on someone's face when the person is happy? (a smile)
11- What do you expect to see in the sky in a beautiful night? (stars, the moon, shooting stars)
12- Describe turtles (slow)
13- What can happen when it is very cold? (snow)
14- What do you do every night? (sleep)

Appendix D – Paragraph reading test

Please call Stella. Ask her to bring these things with her from the store: Six spoons of fresh snow peas, five thick slabs of blue cheese, and maybe a snack for her brother Bob. We also need a small plastic snake and a big toy frog for the kids. She can scoop these things into three red bags, and we will go meet her Wednesday at the train station. (http://accent.gmu.edu/pdfs/elicitation.pdf)

Appendix E – Text-reading test



BBC Education (Words and Pictures) http://www.bbc.co.uk/education/wordsandpictures

The story of Sleeping Beauty

Once upon a time three smiling fairies went to see a baby called Rose to give her special good luck wishes. But then a bad fairy sneaked in, waving her magic stick.
"Be careful, Princess" she screamed. "And beware of Spinning Wheels!"

The princess grew up happily until one day she discovered a spooky, hidden room with an old Spinning Wheel in the corner. As she reached out to touch it, she pricked her finger and the wicked spell made her fall asleep for a hundred years.

One snowy day, a prince came riding up to the castle. He swung his axe and chopped down the sharp rose brambles which had covered the stone walls.

He found Sleeping Beauty and fell in love with her. As he kissed her, the spell was broken and she woke up.

They were married in springtime and lived happily ever after.

A traditional fairy tale - Retold by Brenda Casey

Illustrated by Christopher Gunson

Appendix F – Phrase-reading test

ADVERB
IF LATE
HOW SMILES
HOW SMALL
MOVE SMALL
HOW SLAP
MOVE SNAIL
HOW STOP
HOW SPEAK
MOVE SPEAK
HOW SPORT
MOVE SLOW
MOVE SMILES
IF SMALL
MOVE SNOW
SLAP
SNOW
MOVE SPORT
IF SMILES
MOVE SLAP
IF SPRING
HOW SNOW
HOW STONE
IF SLOW
SMILES

HOW SPRING
IF SNAIL
IF SPORT
IF STONE
MOVE STONE
SMALL
HOW SCREAM
HOW SLOW
IF STOP
IF SNOW
IF SLAP
MOVE SCREAM
MOVE SPRING
MOVE STOP
IF SPEAK
SNAIL
SLOW
MOVE SCAN
HOW SNAIL
IF SCREAM
IF SCAN
HOW SCAN

Appendix G - DISCRIMINATION TEST

	SCRIPT	**file**		**file**
T1	IF SCAN	T2S96	IFFY SCAN	T3S99
T2	IFFY SMILES	T3S6	IFFY SMILES	T2S6
T3	HOW STONE	T2S76	HOW STONE	T3S76
T4	MOVE SLAP	T2S46	MOVIES LAP	T3S53
1	MOVE SLOW	T3S29	MOVIE SLOW	T1S33
2	MOVIE SLOW	T3S33	MOVIE SLOW	T2S33
3	HOWEY STOP	T2s85	HOW STOP	T3s82
4	MOVE SLOW	T2s29	MOVE SLOW	T3s29
5	HOW STOP	T3s82	HOW STOP	T2s82
6	MOVE SLOW	T3s29	MOVIE SLOW	T2s33
7	MOVE SLOW	T2s29	MOVES LOW	T3S43
8	MOVIE SLOW	T3S33	MOVE SLOW	T2S29
9	MOVE SLOW	T1S29	MOVES LOW	T3S43
10	MOVIE SLOW	T2s33	MOVIE SLOW	T3s33
1	HOW SLOW	T3s27	HOW SLOW	T2s27
2	HOW STOP	T2s82	HOW STOP	T3s82
3	MOVES LOW	T3S43	MOVES LOW	T2S43
4	HOW STOP	T2s82	HOWEY STOP	T3s85
5	MOVE SLOW	T3S29	MOVES LOW	T2S43
6	HOW SLOW	T2s27	HOW SLOW	T3s27
7	MOVE SLOW	T3s29	MOVE SLOW	T2s29
8	MOVE STOP	T2s83	MOVE STOP	T3s83
9	MOVE STOP	T3s83	MOVE STOP	T2s83
10	HOWEY SLOW	T3s31	HOWEY SLOW	T2s31
1	HOW IS LOW	T2s34	HOW SLOW	T3s27
2	MOVE SLOW	T3S29	MOVIE SLOW	T2S33
3	MOVE STOP	T3S83	MOVIE STOP	T2S86
4	MOVIE SLOW	T2S33	MOVIE SLOW	T3S33
5	MOVES LOW	T3S43	MOVE SLOW	T2S29

6	MOVE SLOW	T2s29	MOVIE SLOW	T3s33
7	HOW IS LOW	T2S34	HOW IS LOW	T3S34
8	HOWEY SLOW	T2S31	HOW SLOW	T3S27
9	MOVIE STOP	T3S86	MOVIE STOP	T2S86
10	MOVE SLOW	T2S29	MOVIES LOW	T3S40
1	MOVIE SLOW	T3S33	MOVE SLOW	T2S29
2	MOVE SLOW	T1S29	MOVIE SLOW	T3S33
3	HOW SLOW	T3S27	HOW’S LOW	T2S42
4	MOVIE STOP	T2S86	MOVE STOP	T3S83
5	HOW SLOW	T2S27	HOWEY SLOW	T3S31
6	MOVES LOW	T3S43	MOVES LOW	T1S43
7	HOW IS LOW	T3S34	HOW IS LOW	T2S34
8	HOWEY STOP	T2S85	HOWEY STOP	T3S85
9	MOVES LOW	T1S43	MOVES LOW	T3S43
10	MOVE SLOW	T2S29	MOVE SLOW	T3S29
1	HOW SLOW	T3S27	HOW IS LOW	T2S34
2	MOVIE SLOW	T1S33	MOVIE SLOW	T3S33
3	HOW STOP	T3s82	HOWEY STOP	T2s85
4	MOVIE STOP	T2S86	MOVIE STOP	T3S86
5	MOVES LOW	T3S43	MOVES LOW	T2S43
6	MOVE SLOW	T3s29	MOVES LOW	T2S43
7	MOVE SLOW	T2S29	MOVES LOW	T3S43
8	MOVE SLOW	T3S29	MOVE SLOW	T2S29
9	MOVIES LOW	T3S40	MOVE SLOW	T2S29
10	HOW’S LOW	T2S42	HOW SLOW	T3S27
1	HOWEY STOP	T3s85	HOW STOP	T2s82
2	MOVIE SLOW	T3s33	MOVIE SLOW	T2s33
3	HOW’S LOW	T2S42	HOW’S LOW	T3S42
4	HOW IS LOW	T3s34	HOW SLOW	T2s27
5	MOVIES LOW	T3S40	MOVIES LOW	T2S40

6	MOVIES LOW	T2S40	MOVIES LOW	T3S40
7	MOVIE SLOW	T3S33	MOVIE SLOW	T1S33
8	HOWEY SLOW	T2s31	HOWEY SLOW	T3s31
9	MOVIE STOP	T3S86	MOVE STOP	T2S83
10	MOVES LOW	T2S43	MOVE SLOW	T3S29
1	MOVES LOW	T343	MOVE SLOW	T229
2	HOWEY STOP	T3S85	HOWEY STOP	T2S85
3	HOW’S LOW	T3S42	HOW’S LOW	T2S42
4	MOVE SLOW	T3S29	MOVES LOW	T1S43
5	HOW SLOW	T3S27	HOWEY SLOW	T2S31
6	HOW’S LOW	T3S42	HOW SLOW	T2S27
7	MOVES LOW	T1S43	MOVE SLOW	T3S29
8	MOVE STOP	T2S83	MOVIE STOP	T3S86
9	MOVES LOW	T3S43	MOVES LOW	T2S43
10	MOVES LOW	T243	MOVE SLOW	T3S29
1	MOVIE SLOW	T1S33	MOVE SLOW	T3S29
2	MOVES LOW	T2S43	MOVES LOW	T3S43
3	MOVIE SLOW	T2S33	MOVE SLOW	T3S29
4	HOW SLOW	T2S27	HOW’S LOW	T3S42
5	MOVES LOW	T2S43	MOVES LOW	T3S43
6	MOVIES LOW	T2S40	MOVE SLOW	T3S29
7	MOVE SLOW	T3S29	MOVIES LOW	T2S40
8	MOVE SLOW	T1S29	MOVE SLOW	T3S29
9	MOVIE SLOW	T2S33	MOVE SLOW	T3S29
10	MOVE SLOW	T3S29	MOVIE SLOW	T2S33
1	HOW SLOW	T2S27	HOW IS LOW	T3S34
2	MOVES LOW	T3S43	MOVE SLOW	T1S29
3	MOVE SLOW	T3S29	MOVE SLOW	T1S29
4	HOWEY SLOW	T3S31	HOW SLOW	T2S27
84				

DISCRIMINATION TEST – STUDENT ANSWER SHEET

DATE:

NAME: ____

	SAME	**DIFFERENT**
T1		
T2		
T3		
T4		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		

2		
3		
4		
5		
6		
7		
8		
9		
10		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		

2		
3		
4		
5		
6		
7		
8		
9		
10		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
1		

2		
3		
4		
5		

Appendix H - IDENTIFICATION TEST

SOUND FILE	CORRECT OPTION		A	B
T2S95	A		MOVE SCAN	MOVIE SCAN
81	B		IF STONE	IFFY STONE
47	A		SLAP	IS LAP
6	B	1	IF SMILES	IFFY SMILES
27	A	2	HOW SLOW	HOWEY SLOW
59	A	3	MOVE SNAIL	MOVIES NAIL
74	B	4	MOVE SPORT	MOVIE SPORT
T3S29	A	5	MOVE SLOW	MOVIE SLOW
98	B	6	MOVE SCAN	MOVIE SCAN
65	B	7	IF SNAIL	IF IS NAIL
60	A	8	SNAIL	IS NAIL
27	A	9	HOW SLOW	HOW IS LOW
58	A	10	IF SNAIL	IFFY SNAIL
41	B	1	SLOW	IS LOW
67	B	2	SNAIL	IS NAIL
29	A	3	MOVE SLOW	MOVES LOW
7	B	4	MOVE SMILES	MOVIE SMILES
3	A	5	MOVE SMILES	MOVIES MILES
64	B	6	HOW SNAIL	HOW IS NAIL
84	A	7	IF STOP	IFFY STOP
2	A	8	IF SMILES	IF IS MILES
70	A	9	HOW SPORT	HOWEY SPORT
13	B	10	MOVE SMILES	MOVES MILES
T1S43	B	1	MOVE SLOW	MOVES LOW
57	A	2	HOW SNAIL	HOWEY SNAIL
4	A	3	SMILES	IS MILES
86	B	4	MOVE STOP	MOVIE STOP
1	A	5	HOW SMILES	HOWEY SMILES

34	B	6	HOW SLOW	HOW IS LOW
73	B	7	HOW SPORT	HOWEY SPORT
T3S43	B	8	MOVE SLOW	MOVES LOW
83	A	9	MOVE STOP	MOVIE STOP
57	A	10	HOW SNAIL	HOW IS NAIL
12	B	1	HOW SMILES	HOW’S MILES
2	A	2	IF SMILES	IFFY SMILES
71	A	3	MOVE SPORT	MOVIE SPORT
57	A	4	HOW SNAIL	HOW’S NAIL
2	A	5	HOW SLOW	HOW’S LOW
5	B	6	HOW SMILES	HOWEY SMILES
94	A	7	HOW SCAN	HOWEY SCAN
3	A	8	MOVE SMILES	MOVES MILES
87	B	9	IF STOP	IFFY STOP
28	A	10	IF SLOW	IF IS LOW
95	A	1	MOVE SCAN	MOVIE SCAN
9	B	2	IF SMILES	IF IS MILES
8	B	3	HOW SMILES	HOW IS MILES
32	B	4	IF SLOW	IFFY SLOW
31	B	5	HOW SLOW	HOWEY SLOW
61	B	6	HOW SNAIL	HOWEY SNAIL
82	A	7	HOW STOP	HOWEY STOP
T1S29	A	8	MOVE SLOW	MOVES LOW
40	B	9	MOVE SLOW	MOVIES LOW
68	B	10	HOW SNAIL	HOW’S NAIL
T3S33	B	1	MOVE SLOW	MOVIE SLOW
66	B	2	MOVE SNAIL	MOVIES NAIL
96	A	3	IF SCAN	IFFY SCAN
69	B	4	MOVE SNAIL	MOVES NAIL

33	B	5	MOVE SLOW	MOVIE SLOW
75	B	6	IF SPORT	IFFY SPORT
35	B	7	IF SLOW	IF IS LOW
1	A	8	HOW SMILES	HOW'S MILES
99	B	9	IF SCAN	IFFY SCAN
T3S29	A	10	MOVE SLOW	MOVES LOW
63	B	1	MOVE SNAIL	MOVIE SNAIL
3	A	2	MOVE SMILES	MOVIE SMILES
72	A	3	IF SPORT	IFFY SPORT
85	B	4	HOW STOP	HOWEY STOP
42	B	5	HOW SLOW	HOW'S LOW
29	A	6	MOVE SLOW	MOVIE SLOW
43	B	7	MOVE SLOW	MOVES LOW
59	A	8	MOVE SNAIL	MOVIE SNAIL
62	B	9	IF SNAIL	IFFY SNAIL
29	A	10	MOVE SLOW	MOVIES LOW
T1S29	A	1	MOVE SLOW	MOVIE SLOW
10	B	2	MOVE SMILES	MOVIES MILES
30	A	3	SLOW	IS LOW
58	A	4	IF SNAIL	IF IS SNAIL
28	A	5	IF SLOW	IFFY SLOW
97	B	6	HOW SCAN	HOWEY SCAN
1	A	7	HOW SMILES	HOW IS MILES
T1S33	B	8	MOVE SLOW	MOVIE SLOW
59	A	9	MOVE SNAIL	MOVES NAIL
11	B	10	SMILES	IS MILES
80				

IDENTIFICATION TEST – STUDENT ANSWER SHEET

DATE:

NAME: ____

	A	B
1	MOVE SCAN	MOVIE SCAN
2	IF STONE	IFFY STONE
3	SLAP	IS LAP
1	IF SMILES	IFFY SMILES
2	HOW SLOW	HOWEY SLOW
3	MOVE SNAIL	MOVIES NAIL
4	MOVE SPORT	MOVIE SPORT
5	MOVE SLOW	MOVIE SLOW
6	MOVE SCAN	MOVIE SCAN
7	IF SNAIL	IF IS NAIL
8	SNAIL	IS NAIL
9	HOW SLOW	HOW IS LOW
10	IF SNAIL	IFFY SNAIL
1	SLOW	IS LOW
2	SNAIL	IS NAIL
3	MOVE SLOW	MOVES LOW
4	MOVE SMILES	MOVIE SMILES
5	MOVE SMILES	MOVIES MILES
6	HOW SNAIL	HOW IS NAIL

7	IF STOP	IFFY STOP
8	IF SMILES	IF IS MILES
9	HOW SPORT	HOWEY SPORT
10	MOVE SMILES	MOVES MILES
1	MOVE SLOW	MOVES LOW
2	HOW SNAIL	HOWEY SNAIL
3	SMILES	IS MILES
4	MOVE STOP	MOVIE STOP
5	HOW SMILES	HOWEY SMILES
6	HOW SLOW	HOW IS LOW
7	HOW SPORT	HOWEY SPORT
8	MOVE SLOW	MOVES LOW
9	MOVE STOP	MOVIE STOP
10	HOW SNAIL	HOW IS NAIL
1	HOW SMILES	HOW’S MILES
2	IF SMILES	IFFY SMILES
3	MOVE SPORT	MOVIE SPORT
4	HOW SNAIL	HOW’S NAIL
5	HOW SLOW	HOW’S LOW
6	HOW SMILES	HOWEY SMILES
7	HOW SCAN	HOWEY SCAN
8	MOVE SMILES	MOVES MILES
9	IF STOP	IFFY STOP

10	IF SLOW	IF IS LOW
1	MOVE SCAN	MOVIE SCAN
2	IF SMILES	IF IS MILES
3	HOW SMILES	HOW IS MILES
4	IF SLOW	IFFY SLOW
5	HOW SLOW	HOWEY SLOW
6	HOW SNAIL	HOWEY SNAIL
7	HOW STOP	HOWEY STOP
8	MOVE SLOW	MOVES LOW
9	MOVE SLOW	MOVIES LOW
10	HOW SNAIL	HOW’S NAIL
1	MOVE SLOW	MOVIE SLOW
2	MOVE SNAIL	MOVIES NAIL
3	IF SCAN	IFFY SCAN
4	MOVE SNAIL	MOVES NAIL
5	MOVE SLOW	MOVIE SLOW
6	IF SPORT	IFFY SPORT
7	IF SLOW	IF IS LOW
8	HOW SMILES	HOW’S MILES
9	IF SCAN	IFFY SCAN
10	MOVE SLOW	MOVES LOW
1	MOVE SNAIL	MOVIE SNAIL
2	MOVE SMILES	MOVIE SMILES

3	IF SPORT	IFFY SPORT
4	HOW STOP	HOWEY STOP
5	HOW SLOW	HOW’S LOW
6	MOVE SLOW	MOVIE SLOW
7	MOVE SLOW	MOVES LOW
8	MOVE SNAIL	MOVIE SNAIL
9	IF SNAIL	IFFY SNAIL
10	MOVE SLOW	MOVIES LOW
1	MOVE SLOW	MOVIE SLOW
2	MOVE SMILES	MOVIES MILES
3	SLOW	IS LOW
4	IF SNAIL	IF IS SNAIL
5	IF SLOW	IFFY SLOW
6	HOW SCAN	HOWEY SCAN
7	HOW SMILES	HOW IS MILES
8	MOVE SLOW	MOVIE SLOW
9	MOVE SNAIL	MOVES NAIL
10	SMILES	IS MILES
1	IF SMILE	IFFY SMILE

Appendix I – Training design

SESSION	BLOCK	STIMULI			
		FILE	BOTÃO CORRETO	BOTÃO ERRADO	REPETIÇÕES
1	1	T3S72	IF SPORT	IFFY SPORT	4
		T3S75	IFFY SPORT	IF SPORT	4
		T3S90	IF SPEAK	IFFY SPEAK	4
		T3S93	IFFY SPEAK	IF SPEAK	4
	2	T3ST1	MOVE SPORT	MOVIE SPORT	4
		T3ST4	MOVIE SPORT	MOVE SPORT	4
		T3S89	MOVE SPEAK	MOVIE SPEAK	4
		T3S92	MOVIE SPEAK	MOVE SPEAK	4
	3	T3S70	HOW SPORT	HOWEY SPORT	4
		T3S73	HOWEY SPORT	HOW SPORT	4
		T3S88	HOW SPEAK	HOWEY SPEAK	4
		T3S91	HOWEY SPEAK	HOW SPEAK	4
	4	T3S78	IF STONE	IFFY STONE	4
		T3S81	IFFY STONE	IF STONE	4
		T3S84	IF STOP	IFFY STOP	4
		T3S87	IFFY STOP	IF STOP	4
	5	T3S77	MOVE STONE	MOVIE STONE	4
		T3S80	MOVIE STONE	MOVE STONE	4
		T3S83	MOVE STOP	MOVIE STOP	4
		T3S86	MOVIE STOP	MOVE STOP	4
	6	T3S76	HOW STONE	HOWEY STONE	4
		T3S79	HOWEY STONE	HOW STONE	4
		T3S82	HOW STOP	HOWEY STOP	4
		T3S85	HOWEY STOP	HOW STOP	4
	7	T3S2	IF SMILES	IFFY SMILES	4
		T3S6	IFFY SMILES	IF SMILES	4
		T3S15	IF SMALL	IFFY SMALL	4
		T3S19	IFFY SMALL	IF SMALL	4
	8	T3S3	MOVE SMILES	MOVIE SMILES	4
		T3S7	MOVIE SMILES	MOVE SMILES	4
		T3S16	MOVE SMALL	MOVIE SMALL	4
		T3S20	MOVIE SMALL	MOVE SMALL	4
	9	T3S1	HOW SMILES	HOWEY SMILES	4
		T3S5	HOWEY SMILES	HOW SMILES	4
		T3S14	HOW SMALL	HOWEY SMALL	4
		T3S18	HOWEY SMALL	HOW SMALL	4
	10	T3S28	IF SLOW	IFFY SLOW	4
		T3S32	IFFY SLOW	IF SLOW	4
		T3S45	IF SLAP	IFFY SLAP	4
		T3S49	IFFY SLAP	IF SLAP	4
	11	T3S29	MOVE SLOW	MOVIE SLOW	4
		T3S33	MOVIE SLOW	MOVE SLOW	4
		T3S46	MOVE SLAP	MOVIE SLAP	4
		T3S50	MOVIE SLAP	MOVE SLAP	4
	12	T3S27	HOW SLOW	HOWEY SLOW	4
		T3S31	HOWEY SLOW	HOW SLOW	4
		T3S44	HOW SLAP	HOWEY SLAP	4
		T3S48	HOWEY SLAP	HOW SLAP	4
	13	T3S4	SMILES	IS MILES	4
		T3S11	IS MILES	SMILES	4
		T3S17	SMALL	IS MALL	4
		T3S24	IS MALL	SMALL	4
	14	T3S2	IF SMILES	IF IS MILES	4
		T3S9	IF IS MILES	IF SMILES	4
		T3S15	IF SMALL	IF IS MALL	4
		T3S22	IF IS MALL	IF SMALL	4
	15	T3S3	MOVE SMILES	MOVIES MILES	4

		T3S10	MOVIES MILES	MOVE SMILES	4
		T3S16	MOVE SMALL	MOVIES MALL	4
		T3S23	MOVIES MALL	MOVE SMALL	4
	16	T3S1	HOW SMILES	HOW IS MILES	4
		T3S8	HOW IS MILES	HOW SMILES	4
		T3S14	HOW SMALL	HOW IS MALL	4
		T3S21	HOW IS MALL	HOW SMALL	4
	17	T3S30	SLOW	IS LOW	4
		T3S41	IS LOW	SLOW	4
		T3S47	SLAP	IS LAP	4
		T3S54	IS LAP	SLAP	4
	18	T3S28	IF SLOW	IF IS LOW	4
		T3S35	IF IS LOW	IF SLOW	4
		T3S45	IF SLAP	IF IS LAP	4
		T3S52	IF IS LAP	IF SLAP	4
	19	T3S29	MOVE SLOW	MOVIES LOW	4
		T3S40	MOVIES LOW	MOVE SLOW	4
		T3S46	MOVE SLAP	MOVIES LAP	4
		T3S53	MOVIES LAP	MOVE SLAP	4
	20	T3S27	HOW SLOW	HOW IS LOW	4
		T3S34	HOW IS LOW	HOW SLOW	4
		T3S44	HOW SLAP	HOW IS LAP	4
		T3S51	HOW IS LAP	HOW SLAP	4
	21	T3S3	MOVE SMILES	MOVES MILES	4
		T3S13	MOVES MILES	MOVE SMILES	4
		T3S16	MOVE SMALL	MOVES MALL	4
		T3S26	MOVES MALL	MOVE SMALL	4
	22	T3S1	HOW SMILES	HOW’S MILES	4
		T3S12	HOW’S MILES	HOW SMILES	4
		T3S14	HOW SMALL	HOW’S MALL	4
		T3S25	HOW’S MALL	HOW SMALL	4
	23	T3S29	MOVE SLOW	MOVES LOW	4
		T3S43	MOVES LOW	MOVE SLOW	4
		T3S46	MOVE SLAP	MOVES LAP	4
		T3S56	MOVES LAP	MOVE SLAP	4
1	24	T3S27	HOW SLOW	HOW’S LOW	4
		T3S42	HOW’S LOW	HOW SLOW	4
		T3S44	HOW SLAP	HOW’S LAP	4
		T3S55	HOW’S LAP	HOW SLAP	4

SESSION	**BLOCK**	**STIMULI**			
		FILE	**BOTÃO CORRETO**	**BOTÃO ERRADO**	**REPETIÇÕES**
2	1	T1S72	IF SPORT	IFFY SPORT	4
		T1S75	IFFY SPORT	IF SPORT	4
		T1S90	IF SPEAK	IFFY SPEAK	4
		T1S93	IFFY SPEAK	IF SPEAK	4
	2	T1ST1	MOVE SPORT	MOVIE SPORT	4
		T1ST4	MOVIE SPORT	MOVE SPORT	4
		T1S89	MOVE SPEAK	MOVIE SPEAK	4
		T1S92	MOVIE SPEAK	MOVE SPEAK	4
	3	T1S70	HOW SPORT	HOWEY SPORT	4
		T1S73	HOWEY SPORT	HOW SPORT	4
		T1S88	HOW SPEAK	HOWEY SPEAK	4
		T1S91	HOWEY SPEAK	HOW SPEAK	4
	4	T1S78	IF STONE	IFFY STONE	4
		T1S81	IFFY STONE	IF STONE	4
		T1S84	IF STOP	IFFY STOP	4
		T1S87	IFFY STOP	IF STOP	4
	5	T1S77	MOVE STONE	MOVIE STONE	4
		T1S80	MOVIE STONE	MOVE STONE	4
		T1S83	MOVE STOP	MOVIE STOP	4
		T1S86	MOVIE STOP	MOVE STOP	4

	6	T1S76	HOW STONE	HOWEY STONE	4
		T1S79	HOWEY STONE	HOW STONE	4
		T1S82	HOW STOP	HOWEY STOP	4
		T1S85	HOWEY STOP	HOW STOP	4
	7	T1S2	IF SMILES	IFFY SMILES	4
		T1S6	IFFY SMILES	IF SMILES	4
		T1S15	IF SMALL	IFFY SMALL	4
		T1S19	IFFY SMALL	IF SMALL	4
	8	T1S3	MOVE SMILES	MOVIE SMILES	4
		T1S7	MOVIE SMILES	MOVE SMILES	4
		T1S16	MOVE SMALL	MOVIE SMALL	4
		T1S20	MOVIE SMALL	MOVE SMALL	4
	9	T1S1	HOW SMILES	HOWEY SMILES	4
		T1S5	HOWEY SMILES	HOW SMILES	4
		T1S14	HOW SMALL	HOWEY SMALL	4
		T1S18	HOWEY SMALL	HOW SMALL	4
	10	T1S28	IF SLOW	IFFY SLOW	4
		T1S32	IFFY SLOW	IF SLOW	4
		T1S45	IF SLAP	IFFY SLAP	4
		T1S49	IFFY SLAP	IF SLAP	4
	11	T1S29	MOVE SLOW	MOVIE SLOW	4
		T1S33	MOVIE SLOW	MOVE SLOW	4
		T1S46	MOVE SLAP	MOVIE SLAP	4
		T1S50	MOVIE SLAP	MOVE SLAP	4
	12	T1S27	HOW SLOW	HOWEY SLOW	4
		T1S31	HOWEY SLOW	HOW SLOW	4
		T1S44	HOW SLAP	HOWEY SLAP	4
		T1S48	HOWEY SLAP	HOW SLAP	4
	13	T1S4	SMILES	IS MILES	4
		T1S11	IS MILES	SMILES	4
		T1S17	SMALL	IS MALL	4
		T1S24	IS MALL	SMALL	4
	14	T1S2	IF SMILES	IF IS MILES	4
		T1S9	IF IS MILES	IF SMILES	4
		T1S15	IF SMALL	IF IS MALL	4
		T1S22	IF IS MALL	IF SMALL	4
	15	T1S3	MOVE SMILES	MOVIES MILES	4
		T1S10	MOVIES MILES	MOVE SMILES	4
		T1S16	MOVE SMALL	MOVIES MALL	4
		T1S23	MOVIES MALL	MOVE SMALL	4
	16	T1S1	HOW SMILES	HOW IS MILES	4
		T1S8	HOW IS MILES	HOW SMILES	4
		T1S14	HOW SMALL	HOW IS MALL	4
		T1S21	HOW IS MALL	HOW SMALL	4
	17	T1S30	SLOW	IS LOW	4
		T1S41	IS LOW	SLOW	4
		T1S47	SLAP	IS LAP	4
		T1S54	IS LAP	SLAP	4
	18	T1S28	IF SLOW	IF IS LOW	4
		T1S35	IF IS LOW	IF SLOW	4
		T1S45	IF SLAP	IF IS LAP	4
		T1S52	IF IS LAP	IF SLAP	4
	19	T1S29	MOVE SLOW	MOVIES LOW	4
		T1S40	MOVIES LOW	MOVE SLOW	4
		T1S46	MOVE SLAP	MOVIES LAP	4
		T1S53	MOVIES LAP	MOVE SLAP	4
	20	T1S27	HOW SLOW	HOW IS LOW	4
		T1S34	HOW IS LOW	HOW SLOW	4
		T1S44	HOW SLAP	HOW IS LAP	4
		T1S51	HOW IS LAP	HOW SLAP	4
	21	T1S3	MOVE SMILES	MOVES MILES	4

		T1S13	MOVES MILES	MOVE SMILES	4
		T1S16	MOVE SMALL	MOVES MALL	4
		T1S26	MOVES MALL	MOVE SMALL	4
2	22	T1S1	HOW SMILES	HOW’S MILES	4
		T1S12	HOW’S MILES	HOW SMILES	4
		T1S14	HOW SMALL	HOW’S MALL	4
		T1S25	HOW’S MALL	HOW SMALL	4
	23	T1S29	MOVE SLOW	MOVES LOW	4
		T1S43	MOVES LOW	MOVE SLOW	4
		T1S46	MOVE SLAP	MOVES LAP	4
		T1S56	MOVES LAP	MOVE SLAP	4
	24	T1S27	HOW SLOW	HOW’S LOW	4
		T1S42	HOW’S LOW	HOW SLOW	4
		T1S44	HOW SLAP	HOW’S LAP	4
		T1S55	HOW’S LAP	HOW SLAP	4

SESSION	**BLOCK**	**STIMULI**			
		FILE	**BOTÃO CORRETO**	**BOTÃO ERRADO**	**REPETIÇÕES**
3	1	T1S72	IF SPORT	IFFY SPORT	2
		T1S75	IFFY SPORT	IF SPORT	2
		T1S90	IF SPEAK	IFFY SPEAK	2
		T1S93	IFFY SPEAK	IF SPEAK	2
		T3S72	IF SPORT	IFFY SPORT	2
		T3S75	IFFY SPORT	IF SPORT	2
		T3S90	IF SPEAK	IFFY SPEAK	2
		T3S93	IFFY SPEAK	IF SPEAK	2
	2	T1ST1	MOVE SPORT	MOVIE SPORT	2
		T1ST4	MOVIE SPORT	MOVE SPORT	2
		T1S89	MOVE SPEAK	MOVIE SPEAK	2
		T1S92	MOVIE SPEAK	MOVE SPEAK	2
		T3ST1	MOVE SPORT	MOVIE SPORT	2
		T3ST4	MOVIE SPORT	MOVE SPORT	2
		T3S89	MOVE SPEAK	MOVIE SPEAK	2
		T3S92	MOVIE SPEAK	MOVE SPEAK	2
	3	T1S70	HOW SPORT	HOWEY SPORT	2
		T1S73	HOWEY SPORT	HOW SPORT	2
		T1S88	HOW SPEAK	HOWEY SPEAK	2
		T1S91	HOWEY SPEAK	HOW SPEAK	2
		T3S70	HOW SPORT	HOWEY SPORT	2
		T3S73	HOWEY SPORT	HOW SPORT	2
		T3S88	HOW SPEAK	HOWEY SPEAK	2
		T3S91	HOWEY SPEAK	HOW SPEAK	2
	4	T1S78	IF STONE	IFFY STONE	2
		T1S81	IFFY STONE	IF STONE	2
		T1S84	IF STOP	IFFY STOP	2
		T1S87	IFFY STOP	IF STOP	2
		T3S78	IF STONE	IFFY STONE	2
		T3S81	IFFY STONE	IF STONE	2
		T3S84	IF STOP	IFFY STOP	2
		T3S87	IFFY STOP	IF STOP	2
	5	T1S77	MOVE STONE	MOVIE STONE	2
		T1S80	MOVIE STONE	MOVE STONE	2
		T1S83	MOVE STOP	MOVIE STOP	2
		T1S86	MOVIE STOP	MOVE STOP	2
		T3S77	MOVE STONE	MOVIE STONE	2
		T3S80	MOVIE STONE	MOVE STONE	2
		T3S83	MOVE STOP	MOVIE STOP	2
		T3S86	MOVIE STOP	MOVE STOP	2
	6	T1S76	HOW STONE	HOWEY STONE	2
		T1S79	HOWEY STONE	HOW STONE	2
		T1S82	HOW STOP	HOWEY STOP	2

		T1S85	HOWEY STOP	HOW STOP	2
		T3S76	HOW STONE	HOWEY STONE	2
		T3S79	HOWEY STONE	HOW STONE	2
		T3S82	HOW STOP	HOWEY STOP	2
		T3S85	HOWEY STOP	HOW STOP	2
	7	T1S2	IF SMILES	IFFY SMILES	2
		T1S6	IFFY SMILES	IF SMILES	2
		T1S15	IF SMALL	IFFY SMALL	2
		T1S19	IFFY SMALL	IF SMALL	2
		T3S2	IF SMILES	IFFY SMILES	2
		T3S6	IFFY SMILES	IF SMILES	2
		T3S15	IF SMALL	IFFY SMALL	2
		T3S19	IFFY SMALL	IF SMALL	2
	8	T1S3	MOVE SMILES	MOVIE SMILES	2
		T1S7	MOVIE SMILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIE SMALL	2
		T1S20	MOVIE SMALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIE SMILES	2
		T3S7	MOVIE SMILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIE SMALL	2
		T3S20	MOVIE SMALL	MOVE SMALL	2
	9	T1S1	HOW SMILES	HOWEY SMILES	2
		T1S5	HOWEY SMILES	HOW SMILES	2
		T1S14	HOW SMALL	HOWEY SMALL	2
		T1S18	HOWEY SMALL	HOW SMALL	2
		T3S1	HOW SMILES	HOWEY SMILES	2
		T3S5	HOWEY SMILES	HOW SMILES	2
		T3S14	HOW SMALL	HOWEY SMALL	2
		T3S18	HOWEY SMALL	HOW SMALL	2
	10	T1S28	IF SLOW	IFFY SLOW	2
		T1S32	IFFY SLOW	IF SLOW	2
		T1S45	IF SLAP	IFFY SLAP	2
		T1S49	IFFY SLAP	IF SLAP	2
3		T3S28	IF SLOW	IFFY SLOW	2
		T3S32	IFFY SLOW	IF SLOW	2
		T3S45	IF SLAP	IFFY SLAP	2
		T3S49	IFFY SLAP	IF SLAP	2
	11	T1S29	MOVE SLOW	MOVIE SLOW	2
		T1S33	MOVIE SLOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIE SLAP	2
		T1S50	MOVIE SLAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIE SLOW	2
		T3S33	MOVIE SLOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIE SLAP	2
		T3S50	MOVIE SLAP	MOVE SLAP	2
	12	T1S27	HOW SLOW	HOWEY SLOW	2
		T1S31	HOWEY SLOW	HOW SLOW	2
		T1S44	HOW SLAP	HOWEY SLAP	2
		T1S48	HOWEY SLAP	HOW SLAP	2
		T3S27	HOW SLOW	HOWEY SLOW	2
		T3S31	HOWEY SLOW	HOW SLOW	2
		T3S44	HOW SLAP	HOWEY SLAP	2
		T3S48	HOWEY SLAP	HOW SLAP	2
	13	T1S4	SMILES	IS MILES	2
		T1S11	IS MILES	SMILES	2
		T1S17	SMALL	IS MALL	2
		T1S24	IS MALL	SMALL	2
		T3S4	SMILES	IS MILES	2
		T3S11	IS MILES	SMILES	2
		T3S17	SMALL	IS MALL	2

		T3S24	IS MALL	SMALL	2
	14	T1S2	IF SMILES	IF IS MILES	2
		T1S9	IF IS MILES	IF SMILES	2
		T1S15	IF SMALL	IF IS MALL	2
		T1S22	IF IS MALL	IF SMALL	2
		T3S2	IF SMILES	IF IS MILES	2
		T3S9	IF IS MILES	IF SMILES	2
		T3S15	IF SMALL	IF IS MALL	2
		T3S22	IF IS MALL	IF SMALL	2
	15	T1S3	MOVE SMILES	MOVIES MILES	2
		T1S10	MOVIES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIES MALL	2
		T1S23	MOVIES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIES MILES	2
		T3S10	MOVIES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIES MALL	2
		T3S23	MOVIES MALL	MOVE SMALL	2
	16	T1S1	HOW SMILES	HOW IS MILES	2
		T1S8	HOW IS MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW IS MALL	2
		T1S21	HOW IS MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW IS MILES	2
		T3S8	HOW IS MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW IS MALL	2
		T3S21	HOW IS MALL	HOW SMALL	2
	17	T1S30	SLOW	IS LOW	2
		T1S41	IS LOW	SLOW	2
		T1S47	SLAP	IS LAP	2
		T1S54	IS LAP	SLAP	2
		T3S30	SLOW	IS LOW	2
		T3S41	IS LOW	SLOW	2
		T3S47	SLAP	IS LAP	2
		T3S54	IS LAP	SLAP	2
	18	T1S28	IF SLOW	IF IS LOW	2
		T1S35	IF IS LOW	IF SLOW	2
		T1S45	IF SLAP	IF IS LAP	2
		T1S52	IF IS LAP	IF SLAP	2
		T3S28	IF SLOW	IF IS LOW	2
		T3S35	IF IS LOW	IF SLOW	2
		T3S45	IF SLAP	IF IS LAP	2
		T3S52	IF IS LAP	IF SLAP	2
	19	T1S29	MOVE SLOW	MOVIES LOW	2
		T1S40	MOVIES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIES LAP	2
		T1S53	MOVIES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIES LOW	2
		T3S40	MOVIES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIES LAP	2
		T3S53	MOVIES LAP	MOVE SLAP	2
	20	T1S27	HOW SLOW	HOW IS LOW	2
		T1S34	HOW IS LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW IS LAP	2
		T1S51	HOW IS LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW IS LOW	2
		T3S34	HOW IS LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW IS LAP	2
		T3S51	HOW IS LAP	HOW SLAP	2
	21	T1S3	MOVE SMILES	MOVES MILES	2
		T1S13	MOVES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVES MALL	2
		T1S26	MOVES MALL	MOVE SMALL	2

		T3S3	MOVE SMILES	MOVES MILES	2
		T3S13	MOVES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVES MALL	2
		T3S26	MOVES MALL	MOVE SMALL	2
	22	T1S1	HOW SMILES	HOW'S MILES	2
		T1S12	HOW'S MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW'S MALL	2
		T1S25	HOW'S MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW'S MILES	2
		T3S12	HOW'S MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW'S MALL	2
		T3S25	HOW'S MALL	HOW SMALL	2
	23	T1S29	MOVE SLOW	MOVES LOW	2
		T1S43	MOVES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVES LAP	2
		T1S56	MOVES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVES LOW	2
		T3S43	MOVES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVES LAP	2
		T3S56	MOVES LAP	MOVE SLAP	2
	24	T1S27	HOW SLOW	HOW'S LOW	2
		T1S42	HOW'S LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW'S LAP	2
		T1S55	HOW'S LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW'S LOW	2
		T3S42	HOW'S LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW'S LAP	2
		T3S55	HOW'S LAP	HOW SLAP	2

SESSION	**BLOCK**	**STIMULI**			
		FILE	**BOTÃO CORRETO**	**BOTÃO ERRADO**	**REPETIÇÕES**
4	1	T1S72	IF SPORT	IFFY SPORT	2
		T1S75	IFFY SPORT	IF SPORT	2
		T1S90	IF SPEAK	IFFY SPEAK	2
		T1S93	IFFY SPEAK	IF SPEAK	2
		T3S72	IF SPORT	IFFY SPORT	2
		T3S75	IFFY SPORT	IF SPORT	2
		T3S90	IF SPEAK	IFFY SPEAK	2
		T3S93	IFFY SPEAK	IF SPEAK	2
		T1ST1	MOVE SPORT	MOVIE SPORT	2
		T1ST4	MOVIE SPORT	MOVE SPORT	2
		T1S89	MOVE SPEAK	MOVIE SPEAK	2
		T1S92	MOVIE SPEAK	MOVE SPEAK	2
		T3ST1	MOVE SPORT	MOVIE SPORT	2
		T3ST4	MOVIE SPORT	MOVE SPORT	2
		T3S89	MOVE SPEAK	MOVIE SPEAK	2
		T3S92	MOVIE SPEAK	MOVE SPEAK	2
		T1S70	HOW SPORT	HOWEY SPORT	2
		T1S73	HOWEY SPORT	HOW SPORT	2
		T1S88	HOW SPEAK	HOWEY SPEAK	2
		T1S91	HOWEY SPEAK	HOW SPEAK	2
		T3S70	HOW SPORT	HOWEY SPORT	2
		T3S73	HOWEY SPORT	HOW SPORT	2
		T3S88	HOW SPEAK	HOWEY SPEAK	2
		T3S91	HOWEY SPEAK	HOW SPEAK	2
	2	T1S78	IF STONE	IFFY STONE	2
		T1S81	IFFY STONE	IF STONE	2
		T1S84	IF STOP	IFFY STOP	2
		T1S87	IFFY STOP	IF STOP	2
		T3S78	IF STONE	IFFY STONE	2
		T3S81	IFFY STONE	IF STONE	2

		T3S84	IF STOP	IFFY STOP	2
		T3S87	IFFY STOP	IF STOP	2
		T1S77	MOVE STONE	MOVIE STONE	2
		T1S80	MOVIE STONE	MOVE STONE	2
		T1S83	MOVE STOP	MOVIE STOP	2
		T1S86	MOVIE STOP	MOVE STOP	2
		T3S77	MOVE STONE	MOVIE STONE	2
		T3S80	MOVIE STONE	MOVE STONE	2
		T3S83	MOVE STOP	MOVIE STOP	2
		T3S86	MOVIE STOP	MOVE STOP	2
		T1S76	HOW STONE	HOWEY STONE	2
		T1S79	HOWEY STONE	HOW STONE	2
		T1S82	HOW STOP	HOWEY STOP	2
		T1S85	HOWEY STOP	HOW STOP	2
		T3S76	HOW STONE	HOWEY STONE	2
		T3S79	HOWEY STONE	HOW STONE	2
		T3S82	HOW STOP	HOWEY STOP	2
		T3S85	HOWEY STOP	HOW STOP	2
	3	T1S2	IF SMILES	IFFY SMILES	2
		T1S6	IFFY SMILES	IF SMILES	2
		T1S15	IF SMALL	IFFY SMALL	2
		T1S19	IFFY SMALL	IF SMALL	2
		T3S2	IF SMILES	IFFY SMILES	2
		T3S6	IFFY SMILES	IF SMILES	2
		T3S15	IF SMALL	IFFY SMALL	2
		T3S19	IFFY SMALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIE SMILES	2
		T1S7	MOVIE SMILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIE SMALL	2
		T1S20	MOVIE SMALL	MOVE SMALL	2
4		T3S3	MOVE SMILES	MOVIE SMILES	2
		T3S7	MOVIE SMILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIE SMALL	2
		T3S20	MOVIE SMALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOWEY SMILES	2
		T1S5	HOWEY SMILES	HOW SMILES	2
		T1S14	HOW SMALL	HOWEY SMALL	2
		T1S18	HOWEY SMALL	HOW SMALL	2
		T3S1	HOW SMILES	HOWEY SMILES	2
		T3S5	HOWEY SMILES	HOW SMILES	2
		T3S14	HOW SMALL	HOWEY SMALL	2
		T3S18	HOWEY SMALL	HOW SMALL	2
	4	T1S28	IF SLOW	IFFY SLOW	2
		T1S32	IFFY SLOW	IF SLOW	2
		T1S45	IF SLAP	IFFY SLAP	2
		T1S49	IFFY SLAP	IF SLAP	2
		T3S28	IF SLOW	IFFY SLOW	2
		T3S32	IFFY SLOW	IF SLOW	2
		T3S45	IF SLAP	IFFY SLAP	2
		T3S49	IFFY SLAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIE SLOW	2
		T1S33	MOVIE SLOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIE SLAP	2
		T1S50	MOVIE SLAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIE SLOW	2
		T3S33	MOVIE SLOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIE SLAP	2
		T3S50	MOVIE SLAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOWEY SLOW	2
		T1S31	HOWEY SLOW	HOW SLOW	2
		T1S44	HOW SLAP	HOWEY SLAP	2

		T1S48	HOWEY SLAP	HOW SLAP	2
		T3S27	HOW SLOW	HOWEY SLOW	2
		T3S31	HOWEY SLOW	HOW SLOW	2
		T3S44	HOW SLAP	HOWEY SLAP	2
		T3S48	HOWEY SLAP	HOW SLAP	2
	5	T1S4	SMILES	IS MILES	2
		T1S11	IS MILES	SMILES	2
		T1S17	SMALL	IS MALL	2
		T1S24	IS MALL	SMALL	2
		T3S4	SMILES	IS MILES	2
		T3S11	IS MILES	SMILES	2
		T3S17	SMALL	IS MALL	2
		T3S24	IS MALL	SMALL	2
		T1S2	IF SMILES	IF IS MILES	2
		T1S9	IF IS MILES	IF SMILES	2
		T1S15	IF SMALL	IF IS MALL	2
		T1S22	IF IS MALL	IF SMALL	2
		T3S2	IF SMILES	IF IS MILES	2
		T3S9	IF IS MILES	IF SMILES	2
		T3S15	IF SMALL	IF IS MALL	2
		T3S22	IF IS MALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIES MILES	2
		T1S10	MOVIES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIES MALL	2
		T1S23	MOVIES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIES MILES	2
		T3S10	MOVIES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIES MALL	2
		T3S23	MOVIES MALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOW IS MILES	2
		T1S8	HOW IS MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW IS MALL	2
		T1S21	HOW IS MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW IS MILES	2
		T3S8	HOW IS MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW IS MALL	2
		T3S21	HOW IS MALL	HOW SMALL	2
	6	T1S30	SLOW	IS LOW	2
		T1S41	IS LOW	SLOW	2
		T1S47	SLAP	IS LAP	2
		T1S54	IS LAP	SLAP	2
		T3S30	SLOW	IS LOW	2
		T3S41	IS LOW	SLOW	2
		T3S47	SLAP	IS LAP	2
		T3S54	IS LAP	SLAP	2
		T1S28	IF SLOW	IF IS LOW	2
		T1S35	IF IS LOW	IF SLOW	2
		T1S45	IF SLAP	IF IS LAP	2
		T1S52	IF IS LAP	IF SLAP	2
		T3S28	IF SLOW	IF IS LOW	2
		T3S35	IF IS LOW	IF SLOW	2
		T3S45	IF SLAP	IF IS LAP	2
		T3S52	IF IS LAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIES LOW	2
		T1S40	MOVIES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIES LAP	2
		T1S53	MOVIES LAP	MOVE SLAP	2
4		T3S29	MOVE SLOW	MOVIES LOW	2
		T3S40	MOVIES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIES LAP	2

		T3S53	MOVIES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW IS LOW	2
		T1S34	HOW IS LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW IS LAP	2
		T1S51	HOW IS LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW IS LOW	2
		T3S34	HOW IS LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW IS LAP	2
		T3S51	HOW IS LAP	HOW SLAP	2
	7	T1S3	MOVE SMILES	MOVES MILES	2
		T1S13	MOVES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVES MALL	2
		T1S26	MOVES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVES MILES	2
		T3S13	MOVES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVES MALL	2
		T3S26	MOVES MALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOW’S MILES	2
		T1S12	HOW’S MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW’S MALL	2
		T1S25	HOW’S MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW’S MILES	2
		T3S12	HOW’S MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW’S MALL	2
		T3S25	HOW’S MALL	HOW SMALL	2
	8	T1S29	MOVE SLOW	MOVES LOW	2
		T1S43	MOVES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVES LAP	2
		T1S56	MOVES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVES LOW	2
		T3S43	MOVES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVES LAP	2
		T3S56	MOVES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW’S LOW	2
		T1S42	HOW’S LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW’S LAP	2
		T1S55	HOW’S LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW’S LOW	2
		T3S42	HOW’S LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW’S LAP	2
		T3S55	HOW’S LAP	HOW SLAP	2

SESSION	**BLOCK**	**STIMULI**			
		FILE	**BOTÃO CORRETO**	**BOTÃO ERRADO**	**REPETIÇÕES**
5	1	T1S72	IF SPORT	IFFY SPORT	2
		T1S75	IFFY SPORT	IF SPORT	2
		T1S90	IF SPEAK	IFFY SPEAK	2
		T1S93	IFFY SPEAK	IF SPEAK	2
		T3S72	IF SPORT	IFFY SPORT	2
		T3S75	IFFY SPORT	IF SPORT	2
		T3S90	IF SPEAK	IFFY SPEAK	2
		T3S93	IFFY SPEAK	IF SPEAK	2
		T1ST1	MOVE SPORT	MOVIE SPORT	2
		T1ST4	MOVIE SPORT	MOVE SPORT	2
		T1S89	MOVE SPEAK	MOVIE SPEAK	2
		T1S92	MOVIE SPEAK	MOVE SPEAK	2
		T3ST1	MOVE SPORT	MOVIE SPORT	2
		T3ST4	MOVIE SPORT	MOVE SPORT	2
		T3S89	MOVE SPEAK	MOVIE SPEAK	2

		T3S92	MOVIE SPEAK	MOVE SPEAK	2
		T1S70	HOW SPORT	HOWEY SPORT	2
		T1S73	HOWEY SPORT	HOW SPORT	2
		T1S88	HOW SPEAK	HOWEY SPEAK	2
		T1S91	HOWEY SPEAK	HOW SPEAK	2
		T3S70	HOW SPORT	HOWEY SPORT	2
		T3S73	HOWEY SPORT	HOW SPORT	2
		T3S88	HOW SPEAK	HOWEY SPEAK	2
		T3S91	HOWEY SPEAK	HOW SPEAK	2
	2	T1S78	IF STONE	IFFY STONE	2
		T1S81	IFFY STONE	IF STONE	2
		T1S84	IF STOP	IFFY STOP	2
		T1S87	IFFY STOP	IF STOP	2
		T3S78	IF STONE	IFFY STONE	2
		T3S81	IFFY STONE	IF STONE	2
		T3S84	IF STOP	IFFY STOP	2
		T3S87	IFFY STOP	IF STOP	2
		T1S77	MOVE STONE	MOVIE STONE	2
		T1S80	MOVIE STONE	MOVE STONE	2
		T1S83	MOVE STOP	MOVIE STOP	2
		T1S86	MOVIE STOP	MOVE STOP	2
		T3S77	MOVE STONE	MOVIE STONE	2
		T3S80	MOVIE STONE	MOVE STONE	2
		T3S83	MOVE STOP	MOVIE STOP	2
		T3S86	MOVIE STOP	MOVE STOP	2
		T1S76	HOW STONE	HOWEY STONE	2
		T1S79	HOWEY STONE	HOW STONE	2
		T1S82	HOW STOP	HOWEY STOP	2
		T1S85	HOWEY STOP	HOW STOP	2
5		T3S76	HOW STONE	HOWEY STONE	2
		T3S79	HOWEY STONE	HOW STONE	2
		T3S82	HOW STOP	HOWEY STOP	2
		T3S85	HOWEY STOP	HOW STOP	2
	3	T1S2	IF SMILES	IFFY SMILES	2
		T1S6	IFFY SMILES	IF SMILES	2
		T1S15	IF SMALL	IFFY SMALL	2
		T1S19	IFFY SMALL	IF SMALL	2
		T3S2	IF SMILES	IFFY SMILES	2
		T3S6	IFFY SMILES	IF SMILES	2
		T3S15	IF SMALL	IFFY SMALL	2
		T3S19	IFFY SMALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIE SMILES	2
		T1S7	MOVIE SMILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIE SMALL	2
		T1S20	MOVIE SMALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIE SMILES	2
		T3S7	MOVIE SMILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIE SMALL	2
		T3S20	MOVIE SMALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOWEY SMILES	2
		T1S5	HOWEY SMILES	HOW SMILES	2
		T1S14	HOW SMALL	HOWEY SMALL	2
		T1S18	HOWEY SMALL	HOW SMALL	2
		T3S1	HOW SMILES	HOWEY SMILES	2
		T3S5	HOWEY SMILES	HOW SMILES	2
		T3S14	HOW SMALL	HOWEY SMALL	2
		T3S18	HOWEY SMALL	HOW SMALL	2
	4	T1S28	IF SLOW	IFFY SLOW	2
		T1S32	IFFY SLOW	IF SLOW	2
		T1S45	IF SLAP	IFFY SLAP	2
		T1S49	IFFY SLAP	IF SLAP	2

		T3S28	IF SLOW	IFFY SLOW	2
		T3S32	IFFY SLOW	IF SLOW	2
		T3S45	IF SLAP	IFFY SLAP	2
		T3S49	IFFY SLAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIE SLOW	2
		T1S33	MOVIE SLOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIE SLAP	2
		T1S50	MOVIE SLAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIE SLOW	2
		T3S33	MOVIE SLOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIE SLAP	2
		T3S50	MOVIE SLAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOWEY SLOW	2
		T1S31	HOWEY SLOW	HOW SLOW	2
		T1S44	HOW SLAP	HOWEY SLAP	2
		T1S48	HOWEY SLAP	HOW SLAP	2
		T3S27	HOW SLOW	HOWEY SLOW	2
		T3S31	HOWEY SLOW	HOW SLOW	2
		T3S44	HOW SLAP	HOWEY SLAP	2
		T3S48	HOWEY SLAP	HOW SLAP	2
	3	T1S4	SMILES	IS MILES	2
		T1S11	IS MILES	SMILES	2
		T1S17	SMALL	IS MALL	2
		T1S24	IS MALL	SMALL	2
		T3S4	SMILES	IS MILES	2
		T3S11	IS MILES	SMILES	2
		T3S17	SMALL	IS MALL	2
		T3S24	IS MALL	SMALL	2
		T1S2	IF SMILES	IF IS MILES	2
		T1S9	IF IS MILES	IF SMILES	2
		T1S15	IF SMALL	IF IS MALL	2
		T1S22	IF IS MALL	IF SMALL	2
		T3S2	IF SMILES	IF IS MILES	2
		T3S9	IF IS MILES	IF SMILES	2
		T3S15	IF SMALL	IF IS MALL	2
		T3S22	IF IS MALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIES MILES	2
		T1S10	MOVIES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIES MALL	2
		T1S23	MOVIES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIES MILES	2
		T3S10	MOVIES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIES MALL	2
		T3S23	MOVIES MALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOW IS MILES	2
		T1S8	HOW IS MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW IS MALL	2
		T1S21	HOW IS MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW IS MILES	2
		T3S8	HOW IS MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW IS MALL	2
		T3S21	HOW IS MALL	HOW SMALL	2
	4	T1S30	SLOW	IS LOW	2
		T1S41	IS LOW	SLOW	2
		T1S47	SLAP	IS LAP	2
		T1S54	IS LAP	SLAP	2
5		T3S30	SLOW	IS LOW	2
		T3S41	IS LOW	SLOW	2
		T3S47	SLAP	IS LAP	2
		T3S54	IS LAP	SLAP	2

		T1S28	IF SLOW	IF IS LOW	2
		T1S35	IF IS LOW	IF SLOW	2
		T1S45	IF SLAP	IF IS LAP	2
		T1S52	IF IS LAP	IF SLAP	2
		T3S28	IF SLOW	IF IS LOW	2
		T3S35	IF IS LOW	IF SLOW	2
		T3S45	IF SLAP	IF IS LAP	2
		T3S52	IF IS LAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIES LOW	2
		T1S40	MOVIES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIES LAP	2
		T1S53	MOVIES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIES LOW	2
		T3S40	MOVIES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIES LAP	2
		T3S53	MOVIES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW IS LOW	2
		T1S34	HOW IS LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW IS LAP	2
		T1S51	HOW IS LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW IS LOW	2
		T3S34	HOW IS LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW IS LAP	2
		T3S51	HOW IS LAP	HOW SLAP	2
	3	T1S3	MOVE SMILES	MOVES MILES	2
		T1S13	MOVES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVES MALL	2
		T1S26	MOVES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVES MILES	2
		T3S13	MOVES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVES MALL	2
		T3S26	MOVES MALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOW’S MILES	2
		T1S12	HOW’S MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW’S MALL	2
		T1S25	HOW’S MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW’S MILES	2
		T3S12	HOW’S MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW’S MALL	2
		T3S25	HOW’S MALL	HOW SMALL	2
	4	T1S29	MOVE SLOW	MOVES LOW	2
		T1S43	MOVES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVES LAP	2
		T1S56	MOVES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVES LOW	2
		T3S43	MOVES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVES LAP	2
		T3S56	MOVES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW’S LOW	2
		T1S42	HOW’S LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW’S LAP	2
		T1S55	HOW’S LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW’S LOW	2
		T3S42	HOW’S LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW’S LAP	2
		T3S55	HOW’S LAP	HOW SLAP	2

SESSION	**BLOCK**	**STIMULI**			
		FILE	**BOTÃO CORRETO**	**BOTÃO ERRADO**	**REPETIÇÕES**

6	1 2	T1S72	IF SPORT	IFFY SPORT	2
		T1S75	IFFY SPORT	IF SPORT	2
		T1S90	IF SPEAK	IFFY SPEAK	2
		T1S93	IFFY SPEAK	IF SPEAK	2
		T3S72	IF SPORT	IFFY SPORT	2
		T3S75	IFFY SPORT	IF SPORT	2
		T3S90	IF SPEAK	IFFY SPEAK	2
		T3S93	IFFY SPEAK	IF SPEAK	2
		T1ST1	MOVE SPORT	MOVIE SPORT	2
		T1ST4	MOVIE SPORT	MOVE SPORT	2
		T1S89	MOVE SPEAK	MOVIE SPEAK	2
		T1S92	MOVIE SPEAK	MOVE SPEAK	2
		T3ST1	MOVE SPORT	MOVIE SPORT	2
		T3ST4	MOVIE SPORT	MOVE SPORT	2
		T3S89	MOVE SPEAK	MOVIE SPEAK	2
		T3S92	MOVIE SPEAK	MOVE SPEAK	2
		T1S70	HOW SPORT	HOWEY SPORT	2
		T1S73	HOWEY SPORT	HOW SPORT	2
		T1S88	HOW SPEAK	HOWEY SPEAK	2
		T1S91	HOWEY SPEAK	HOW SPEAK	2
		T3S70	HOW SPORT	HOWEY SPORT	2
		T3S73	HOWEY SPORT	HOW SPORT	2
		T3S88	HOW SPEAK	HOWEY SPEAK	2
		T3S91	HOWEY SPEAK	HOW SPEAK	2
		T1S78	IF STONE	IFFY STONE	2
		T1S81	IFFY STONE	IF STONE	2
		T1S84	IF STOP	IFFY STOP	2
		T1S87	IFFY STOP	IF STOP	2
		T3S78	IF STONE	IFFY STONE	2
		T3S81	IFFY STONE	IF STONE	2
		T3S84	IF STOP	IFFY STOP	2
		T3S87	IFFY STOP	IF STOP	2
		T1S77	MOVE STONE	MOVIE STONE	2
		T1S80	MOVIE STONE	MOVE STONE	2
		T1S83	MOVE STOP	MOVIE STOP	2
		T1S86	MOVIE STOP	MOVE STOP	2
		T3S77	MOVE STONE	MOVIE STONE	2
		T3S80	MOVIE STONE	MOVE STONE	2
		T3S83	MOVE STOP	MOVIE STOP	2
		T3S86	MOVIE STOP	MOVE STOP	2
		T1S76	HOW STONE	HOWEY STONE	2
		T1S79	HOWEY STONE	HOW STONE	2
		T1S82	HOW STOP	HOWEY STOP	2
		T1S85	HOWEY STOP	HOW STOP	2
		T3S76	HOW STONE	HOWEY STONE	2
		T3S79	HOWEY STONE	HOW STONE	2
		T3S82	HOW STOP	HOWEY STOP	2
		T3S85	HOWEY STOP	HOW STOP	2
	3 4	T1S2	IF SMILES	IFFY SMILES	2
		T1S6	IFFY SMILES	IF SMILES	2
		T1S15	IF SMALL	IFFY SMALL	2
		T1S19	IFFY SMALL	IF SMALL	2
		T3S2	IF SMILES	IFFY SMILES	2
		T3S6	IFFY SMILES	IF SMILES	2
		T3S15	IF SMALL	IFFY SMALL	2
		T3S19	IFFY SMALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIE SMILES	2
		T1S7	MOVIE SMILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIE SMALL	2
		T1S20	MOVIE SMALL	MOVE SMALL	2

		T3S3	MOVE SMILES	MOVIE SMILES	2
		T3S7	MOVIE SMILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIE SMALL	2
		T3S20	MOVIE SMALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOWEY SMILES	2
		T1S5	HOWEY SMILES	HOW SMILES	2
		T1S14	HOW SMALL	HOWEY SMALL	2
		T1S18	HOWEY SMALL	HOW SMALL	2
		T3S1	HOW SMILES	HOWEY SMILES	2
		T3S5	HOWEY SMILES	HOW SMILES	2
		T3S14	HOW SMALL	HOWEY SMALL	2
		T3S18	HOWEY SMALL	HOW SMALL	2
		T1S28	IF SLOW	IFFY SLOW	2
		T1S32	IFFY SLOW	IF SLOW	2
		T1S45	IF SLAP	IFFY SLAP	2
		T1S49	IFFY SLAP	IF SLAP	2
		T3S28	IF SLOW	IFFY SLOW	2
		T3S32	IFFY SLOW	IF SLOW	2
		T3S45	IF SLAP	IFFY SLAP	2
		T3S49	IFFY SLAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIE SLOW	2
		T1S33	MOVIE SLOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIE SLAP	2
		T1S50	MOVIE SLAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIE SLOW	2
		T3S33	MOVIE SLOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIE SLAP	2
		T3S50	MOVIE SLAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOWEY SLOW	2
		T1S31	HOWEY SLOW	HOW SLOW	2
		T1S44	HOW SLAP	HOWEY SLAP	2
		T1S48	HOWEY SLAP	HOW SLAP	2
		T3S27	HOW SLOW	HOWEY SLOW	2
		T3S31	HOWEY SLOW	HOW SLOW	2
		T3S44	HOW SLAP	HOWEY SLAP	2
		T3S48	HOWEY SLAP	HOW SLAP	2
	3 4	T1S4	SMILES	IS MILES	2
		T1S11	IS MILES	SMILES	2
		T1S17	SMALL	IS MALL	2
		T1S24	IS MALL	SMALL	2
		T3S4	SMILES	IS MILES	2
		T3S11	IS MILES	SMILES	2
		T3S17	SMALL	IS MALL	2
		T3S24	IS MALL	SMALL	2
		T1S2	IF SMILES	IF IS MILES	2
		T1S9	IF IS MILES	IF SMILES	2
		T1S15	IF SMALL	IF IS MALL	2
		T1S22	IF IS MALL	IF SMALL	2
		T3S2	IF SMILES	IF IS MILES	2
		T3S9	IF IS MILES	IF SMILES	2
		T3S15	IF SMALL	IF IS MALL	2
		T3S22	IF IS MALL	IF SMALL	2
		T1S3	MOVE SMILES	MOVIES MILES	2
		T1S10	MOVIES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVIES MALL	2
		T1S23	MOVIES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVIES MILES	2
		T3S10	MOVIES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVIES MALL	2
		T3S23	MOVIES MALL	MOVE SMALL	2

		T1S1	HOW SMILES	HOW IS MILES	2
		T1S8	HOW IS MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW IS MALL	2
		T1S21	HOW IS MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW IS MILES	2
		T3S8	HOW IS MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW IS MALL	2
		T3S21	HOW IS MALL	HOW SMALL	2
		T1S30	SLOW	IS LOW	2
		T1S41	IS LOW	SLOW	2
		T1S47	SLAP	IS LAP	2
		T1S54	IS LAP	SLAP	2
		T3S30	SLOW	IS LOW	2
		T3S41	IS LOW	SLOW	2
		T3S47	SLAP	IS LAP	2
		T3S54	IS LAP	SLAP	2
		T1S28	IF SLOW	IF IS LOW	2
		T1S35	IF IS LOW	IF SLOW	2
		T1S45	IF SLAP	IF IS LAP	2
		T1S52	IF IS LAP	IF SLAP	2
		T3S28	IF SLOW	IF IS LOW	2
		T3S35	IF IS LOW	IF SLOW	2
		T3S45	IF SLAP	IF IS LAP	2
		T3S52	IF IS LAP	IF SLAP	2
		T1S29	MOVE SLOW	MOVIES LOW	2
		T1S40	MOVIES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVIES LAP	2
		T1S53	MOVIES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVIES LOW	2
		T3S40	MOVIES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVIES LAP	2
		T3S53	MOVIES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW IS LOW	2
		T1S34	HOW IS LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW IS LAP	2
		T1S51	HOW IS LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW IS LOW	2
		T3S34	HOW IS LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW IS LAP	2
		T3S51	HOW IS LAP	HOW SLAP	2
	3 4	T1S3	MOVE SMILES	MOVES MILES	2
		T1S13	MOVES MILES	MOVE SMILES	2
		T1S16	MOVE SMALL	MOVES MALL	2
		T1S26	MOVES MALL	MOVE SMALL	2
		T3S3	MOVE SMILES	MOVES MILES	2
		T3S13	MOVES MILES	MOVE SMILES	2
		T3S16	MOVE SMALL	MOVES MALL	2
		T3S26	MOVES MALL	MOVE SMALL	2
		T1S1	HOW SMILES	HOW’S MILES	2
		T1S12	HOW’S MILES	HOW SMILES	2
		T1S14	HOW SMALL	HOW’S MALL	2
		T1S25	HOW’S MALL	HOW SMALL	2
		T3S1	HOW SMILES	HOW’S MILES	2
		T3S12	HOW’S MILES	HOW SMILES	2
		T3S14	HOW SMALL	HOW’S MALL	2
		T3S25	HOW’S MALL	HOW SMALL	2
		T1S29	MOVE SLOW	MOVES LOW	2
		T1S43	MOVES LOW	MOVE SLOW	2
		T1S46	MOVE SLAP	MOVES LAP	2
		T1S56	MOVES LAP	MOVE SLAP	2
		T3S29	MOVE SLOW	MOVES LOW	2

		T3S43	MOVES LOW	MOVE SLOW	2
		T3S46	MOVE SLAP	MOVES LAP	2
		T3S56	MOVES LAP	MOVE SLAP	2
		T1S27	HOW SLOW	HOW’S LOW	2
		T1S42	HOW’S LOW	HOW SLOW	2
		T1S44	HOW SLAP	HOW’S LAP	2
		T1S55	HOW’S LAP	HOW SLAP	2
		T3S27	HOW SLOW	HOW’S LOW	2
		T3S42	HOW’S LOW	HOW SLOW	2
		T3S44	HOW SLAP	HOW’S LAP	2
		T3S55	HOW’S LAP	HOW SLAP	2