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PÓS-GRADUAÇÃO EM LETRAS/INGLÊS E LITERATURA CORRESPONDENTE

BRAZILIAN EFL LEARNERS' IDENTIFICATION OF WORD-FINAL /m-n/: NATIVE/NONNATIVE REALIZATIONS AND EFFECT OF VISUAL CUES

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To my dad Willy and my mom Ana
To my sisters Anelise, Mariana and Mara, my adopted sister

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ABSTRACT

BRAZILIAN EFL LEARNERS' IDENTIFICATION OF WORD-FINAL /m-n/: NATIVE/NONNATIVE REALIZATIONS AND EFFECT OF VISUAL CUES

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The word-final nasals /m/ and /n/ have different patterns of phonetic realizations across languages, whereas they are distinctively pronounced in English, in Brazilian Portuguese (BP) they are not fully realized. Bearing in mind this phonetic difference, the main objective of this study was to investigate perception of the English word-final nasals /m/ and /n/ by Brazilian learners of English as a foreign language (EFL). More specifically, the present study aimed at (a) investigating whether Brazilian EFL learners were able to identify the native-like realization of English word-final nasals; (b) verifying whether visual cues favored the identification of the target consonants, and (c) whether there was effect of the preceding vowel on the identification of /m/ and /n/. Two perception tests were used: (a) the Native-like versus Nonnative-like Identification Test, which contrasted CVC words produced with both English and BP phonetic /m/ and /n/ realizations, and (b) the Three-condition Identification Test, which contrasted the presence and/or absence of visual cues in the identification of /m/ and /n/ through three types of stimuli presentation—*Audio/Video*, *Video only*, and *Auditory only*. The effect of preceding vowels on the identification of the target consonants was controlled through the use of the six words *Tim-tin*, *gem-gen,* and *cam-can*. Two groups took the two perception tests: ten Americans, whose data were used as a reference for comparison, and the experimental group of forty-two BP intermediate EFL learners. The results indicated that (a) Brazilian listeners were able to identify English nasals' realization when there was contrast between the realizations; (b) whereas *Audio/Video* presentation favored the identification of the target nasals, *Audio only* presentation disfavored it; and (c) there was vowel effect on the identification of both nasals and in both tests, although such effect had different patterns for either consonants or tests.

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RESUMO

IDENTIFICAÇÃO DOS POR BRASILEIROS APRENDIZES DE INGLÊS DE /m-n/ EM POSIÇÃO DE FINAL DE PALAVRA: REALIZAÇÕES NATIVA/NÃO-NATIVA E EFEITO DE PISTAS VISUAIS

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As consoantes nasais /m/ e /n/ em posição final de palavra possuem diversos padrões de realização fonética. Em inglês elas são pronunciadas de forma distintiva, enquanto em português brasileiro (PB) elas não são completamente realizadas. Tendo em vista tal diferença, o principal objetivo deste estudo foi investigar a percepção das nasais inglesas /m/ e /n/ em posição final de palavra por brasileiros aprendizes de inglês como língua estrangeira (ILE). O estudo objetivou (a) investigar se brasileiros conseguem identificar a pronúncia de /m/ e /n/ em posição final de palavra na realização nativa do inglês; (b) verificar se pistas visuais favorece a identificação das consoantes alvos, e (c) examinar se a vogal antecedente às nasais interfere na identificação das mesmas. Dois testes de percepção foram utilizados: (a) o Teste de Identificação de realização Nativa versus Não-nativa; no qual se contrastou palavras com realização fonética de /m/ e /n/ tanto em inglês quanto em PB e (b) o Teste de Identificação de Três-condições, o qual contrastou a presença e/ou ausência de pistas visuais na identificação das nasais através de três formas de apresentação de estímulos—*Áudio-Vídeo, apenas Vídeo,* e *apenas*

Áudio. O efeito da vogal antecedente às nasais foi controlado através do uso das seis palavras *Tim-tin*, *gem-gen*, e *cam-can*. Dois grupos fizeram os testes de percepção: o controle, de dez americanos, e o experimental, de quarenta e dois brasileiros aprendizes de ILE. Os resultados indicaram que (a) os brasileiros tiveram melhor desempenho na identificação da realização nativa quando houve contraste entre os tipos de realizações; (b) enquanto a apresentação de estímulos na forma *Áudio-Vídeo* favoreceu a identificação, a forma *apenas Áudio* impôs dificuldade e (c) a vogal antecedente afetou a identificação de ambas as consoantes nos dois testes, embora os resultados sigam padrões diferentes para as consoantes e para os testes.

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ABBREVIATIONS

A only – Audio only test condition

AE – American English

AV – Audio/Video test condition

BE – British English

BP - Brazilian Portuguese

CDT - Categorial Discrimination Test

EFL - English as foreign language

H - Hypothesis

L1 – First/Native language

L2 – Second/Foreign language

N talker – native talker

N-like – native-like

N-like vs. NN-like Identification Test – Native-like versus Nonnative-like Identification Test

NLM – Native Language Magnet model

NN talker – nonnative talker

NN-like – nonnative-like

RQ – Research question

SLA - Second language acquisition

SLM - Speech Learning Model

UFSC – Universidade Federal de Santa Catarina

UvA – University of Amsterdam

V only – Video only test condition

Chapter 1

Introduction

1.1 Background to the study

Much research related to the perception of second language (L2) sounds has discussed the influence of the native language (L1) on accurate percetion of the L2 (Flege, 1993, 1995; Wode, 1995; Best, 1995; Kuhl & Iverson, 1995). Moreover, some models of L2 speech perception have discussed the role of accurate perception on accurate production (Flege, 1995; Best, 1995; Escudero, 2005; Best & Tyler, 2007). According to some studies (Schmidt, 1996; Harnsberger, 2001a; Best, McRoberts & Goodell, 2001; Best & Tyler, 2007), it is usually believed that, at least in initial stages of L2 learning, adults are language-specific perceivers and that they perceive L2 segments through the filter of their L1 sound system.

Bearing in mind the perspective mentioned above, this dissertation aims at investigating the perception of English word-final nasals consonants /m/ and /n/ by Brazilian learners of English. In order to understand the difficulties Brazilian English as a Foreign Language (EFL) learners may have with nasal consonants in word-final position, phonological differences between the two languages have to be considered. According to Fujimura and Erickson (1997), typically, nasal consonants have a place distinction between / m/ and /n/ as in English. However, some languages have no place distinction for nasal consonants in the coda (syllable-final position), as Brazilian Portuguese (BP), for instance. Due to this difference, the Brazilian EFL learners would be expected to have difficulty in identifying English /m/ and /n/ in word-final position.

As posited by Flege (1981), L2 sounds may be perceived in terms of those of the L1 by the learner, making this perception different from that of a native speaker. For example, sounds that are separate phonemes in an L2 might be merely allophones of the same phoneme in the L1. Furthermore, Flege states that this may influence the production of L2 sounds by a native speaker of this L1 because of the identical mental representation that this speaker has for the two sounds. It could be expected in this study that the participants may perceive English word-final nasals "through the grid" (Wode, 1978, cited in Flege, 1995) of BP nasalization.

Flege (1995) also posits in his Speech Learning Model that the perceived relationship between L1 and L2 categories plays an important role in correctly perceiving or producing L2 sounds. According to one of the hypotheses of this model, L1 and L2 sounds are "related perceptually to one another at a position-sensitive allophonic level" and acquisition of L2 sounds depends on the perceived dissimilarity between L1 and L2 sounds (Flege, 1995, p.239).

Kuhl (1993) proposes the Native Language Magnet model of speech perception and language development, which works with the concept of L1 phonetic prototypes, or the best exemplars of certain phonetic category. These prototypes would act as perceptual magnets that pull the surrounding L2 sounds near the same perceptual phonetic space occupied by the L1 prototype. She states that the nearer the L2 sounds to the L1 prototype, the more difficult to discriminate L1 and L2 speech sounds.

Therefore, in accordance with both perception models and with O'Connor (1992) who suggested that Brazilian learners of English would be expected to have difficulty in identifying English word-final nasals /m/ and /n/, as in BP, these nasal consonants in this position are not distinctive due to vowel nasalization and deletion of the nasal consonant.

Recent studies have included visual cues as a variable to investigate the perception of L2 contrasts (Hardison, 1999; Öhrström & Traunmüller, 2004; Hazan, Sennema, Faulkner, Ortega-Llebaria, Iba and Chung, 2006) and they have shown that L2 listeners seemed to benefit from an Audio/Video presentation in the identification of visually distinctive L2 contrasts (Hazan et al., 2006). As regards the use of visual in the identification of English contrasts by Brazilian EFL learners, there is only one pilot study conducted by Kluge (2007), to the best of my knowledge. This study investigated the effect of visual cues in the identification of English word-final nasals /m/ and /n/ by ten intermediate Brazilian learners. Results from this study showed that Audio/Video condition seemed to favor the accurate identification of English word-final /m/ and /n/ by the participants. Result also showed a slight tendency for the Audio only condition to disfavor the accurate identification of those nasal consonants when compared to Audio/Video condition. As there was a limited number of tokens and participants, the present study also aims at further investigating this variable, as regards presence or absence of visual cues.

1.2 Significance of the Research

Second language acquisition research can provide a testing ground for phonological, phonetic and Second Language Acquisition (SLA) theories. Research in interlanguage phonetics and phonology considering Brazilian English interphonology has produced an increasing number of studies, especially during the past few years. Some of these studies have investigated consonants and their position and combination within the syllable as regards not only perception or production, but also the relationship between them.

As for the studies that investigated only perception of consonants by Brazilian EFL learners, Reis (2008) investigated English initial /θ/ and Moore (2008) investigated English final /l/. As regards studies on only production, Cornelian Junior (2003), Rebello and Baptista (2006) and Rauber (2002, 2006) investigated English initial /s/ clusters; Baratieri (2006) investigated English final /l/; and Baptista and Silva Filho (2006) investigated English final consonants. As for the relationship between the perception and production, there are some studies related to Brazilian EFL learners: Koerich (2002, 2006), investigating vowel paragoge; Silveiro (2004), investigating English compound stress patterns, Reis (2006), investigating initial English /θ/ and /ð/, Bettoni-Techio, Rauber and Koerich (2007), investigating English word-final alveolar stops; and Silveira (2004), investigating English word-final consonants. There is also a study that investigated the perceptual training and word-initial /s/ clusters carried out by Bettoni-Techio (2008).

As regards English consonants /m/ and /n/ in word-final position, there are few studies regarding Brazilian EFL learners, to the best of my knowledge: Becker (2007), investigating only production; Kluge, Reis, Nobre-Oliveira and Rauber (2008), investigating perception by Brazilians and Dutch EFL learners; Kluge (2007), investigating perception and production separately; and Kluge (2004), investigating the relationship between perception and production. Due to the lack of research investigating the perception of those English nasal consonants in word-final position by Brazilian EFL learners, the purpose of this study is to further investigate, verify and explain the findings of previous studies (Kluge 2004, 2007) regarding variables, such as native versus nonnative realization of the nasal consonant, absence versus presence of visual cues, and preceding vowel.

1.3 Objectives and hypotheses

The main objective of this study was to investigate the identification of native/nonnative realization and absence/presence of visual cues on the perception of the English word-final nasals /m/ and /n/ by Brazilian EFL learners assessed by means of two perception tests: a Native-like versus Nonnative-like Identification Test and a Three-condition Identification Test respectively. As previous studies have indicated that the preceding vowel affected the accurate identification of nasal consonants (Sharf & Ostreicher, 1973; Kurowski & Blumstein, 1984; Repp, 1996; Zee, 1981, cited in Kurowski & Blumstein, 1995, p. 199; Kluge, 2004, 2007), this study investigated the effect of preceding vowel in both perception tests. Four research questions and six hypotheses were formulated. Most of the hypotheses were based on the findings of the only two studies that investigated the perception of word-final nasals by Brazilian learners of English, to the best of my knowledge. First, a master thesis conducted by Kluge (2004) from which an article was published (Kluge, Rauber, Reis & Bion, 2007), and second, a pilot study also conducted by Kluge (2007) from which a part was published (Kluge, Reis, Nobre-Oliveira & Bettoni-Techio, 2007; Kluge & Baptista, to appear). These studies will be discussed in detail throughout Chapter 3.

Four objectives guided the present study. The first one aimed at investigating whether the Brazilian learners were able to identify the native-like realization of the English word-final nasals according to the presence or absence of a fully realized English word-final nasal. The second objective was to investigated whether the height of the preceding vowel (high, medium and low) would influence the Brazilian EFL learners' identification of English word-final nasals /m/ and /n/ in the Native-like versus Nonnative-like Identification Test.

As regards the effect of visual cues, the third objective aimed at investigating which of the three conditions tested in the Three-condition Identification Test (Audio only, Audio/Video and Video only) would favor the accurate identification of the English word-final nasal /m/ and /n/. The fourth objective investigated whether the height of the preceding vowel (high, medium and low) would influence the Brazilian EFL learners' identification of English word-final nasals /m/ and /n/ in the Three-condition Identification Test. The specific research questions and the related hypotheses are provided in the Method (Chapter 5).

1.4 Organization of the dissertation

This dissertation is organized into seven chapters. The first three chapters present an overview of the literature relevant to the present study. Chapter 2 presents some relevant articulatory and acoustic characteristics of nasal consonants, regarding specially the bilabial and the alveolar nasal consonants. This chapter also presents an overview of the nasalization in English and in Brazilian Portuguese.

Chapter 3 is divided into three sections. The first section presents a brief review of studies carried out on the production of nasal consonants considering some variables that might influence production such as syllable position, stress and vowel context. Though the present study does no investigate production of the nasal consonants, this section was included because some studies on production are background to studies on perception. The second section reviews some studies on the perception of nasal consonants as regards some relevant variables that might influence such perception, especially the ones addressed in this study. The third section presents some important issues regarding the use of visual cues in the in the perception of nonnative contrast as well as reviews some studies important to this dissertation.

Chapter 4 briefly reviews some current models of speech perception. First, this chapter reviews the Speech Learning Model (SLM) proposed by Flege (1995). Then, it reviews the Native Language Magnet (NLM) model proposed by Kuhl (1991, 1993).

Chapter 5 describes the method used in the present study. It summarizes the research questions and hypotheses, and describes the Brazilian participants and the participants of the control group. It also describes the material and the procedures used to collect the data.

Chapter 6 reports and discusses the results of the performance of the Brazilian participants and the participants of the control group on each of the perception tests of this study. This chapter also provides a comparison between the performance of both groups throughout the chapter and a summary and a further discussion of the results in the last section. Finally, Chapter 7 summarizes the major findings of this study, discusses some pedagogical implications as well as some limitations and suggestions for further research.

Chapter 2

Nasal consonants

This chapter presents an overview of some relevant articulatory and acoustic characteristics of nasal consonants, particularly the bilabial and the alveolar ones (2.1), and discusses the processes of the nasalization in English (2.2) and in BP (2.3).

2.1 Articulatory and acoustic characteristics of nasal consonants

As stated by Lambacher (1995), nasal sounds are found in most languages of the world and the most common type of nasals are bilabials (/m/) and alveolars (/n/). Nasals are similar to oral stop consonants in that both are produced with an obstruction somewhere within the oral cavity. Nasal sounds differ, however, in that they are produced with the entire vocal tract, including both the nasal cavity and nasopharynx. Also, there is no interruption of airflow through the nasal cavity, unlike the obstruction of the nasal passage that is characteristic of oral stop consonants. As described by Stevens (1997) “a nasal consonant is produced by making a complete closure with one of the articulators, while maintaining an open velopharyngeal port” (p. 486). In nasal sounds the velum is lowered, allowing air to escape through the nose; whereas in nonnasal sounds the velum is raised, allowing the air to escape only through the mouth (Giegerich, 1992; Picket, 1998; Kent & Read, 1992).

There are several acoustic consequences of opening the nasal cavity in the production of a nasal consonant which contribute to the acoustic complexity of nasal consonants (Lieberman & Blumstein, 1988; Kurowski & Blumstein, 1995, Kent &

Read, 1992). One of them is the nasal murmur which corresponds to the closure phase of the oral tract during the production of the nasal consonants (Harrington & Cassidy, 1999). Fujimura (1962) describes the nasal murmur as "the sound produced with a complete closure at a point in the oral cavity, and with an appreciable amount of coupling of nasal passages to the vocal tract" (p. 1865). This murmur must occur in the closure interval preceding the consonant release and it is characterized acoustically by a low-frequency spectral prominence around 250Hz and lower amplitude peaks above 700Hz (Fujimura, 1962; Kurowski & Blumstein, 1995; Lieberman & Blumstein, 1988). This murmur may be very short in duration, as little as two glottal pulses.

Fujimura (1962), also states that the spectra of nasal murmurs may not be the same depending on the place of articulation of the nasal consonant. However, he claims that there are some features that characterize the spectra of nasal murmurs in general: the existence of a very low first formant that is located at about 300 Hz and is well separated from the upper formant structure; and high density of the formants in the frequency domain.

Figures 1 and 2 show spectrograms illustrating the nasal consonants /m/ and /n/ in word-final position in the words *Pam* and *tan* (Ladefoged, 2006, p. 193), and *ram* and *ran* (Ladefoged, 2005, p. 55) respectively.

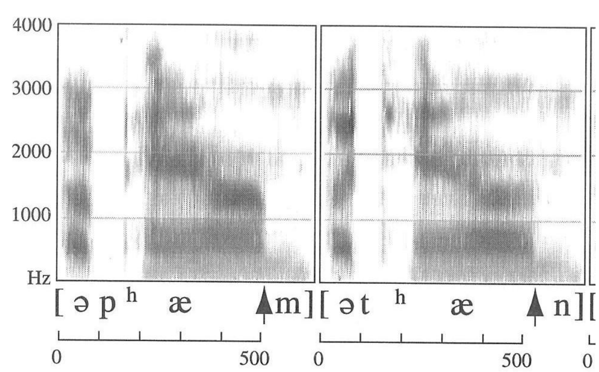

Figure 1. Spectrograms of nasal in word-final position in *Pam* and *tan*. The arrows indicate the oral closures forming the nasal consonants (Ladefoged, 2006, p. 193).

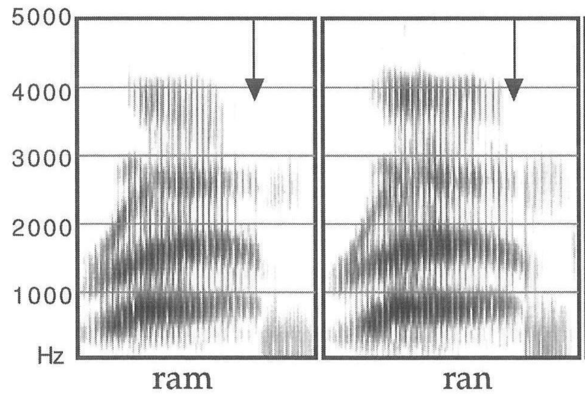

Figure 2. Spectrograms of nasal in word-final position in *ram* and *ran*. The arrows mark the onsets of the nasals (Ladefoged, 2005, p. 55).

From the examples above, Ladefoged (2005, 2006) draws attention to a clear characteristic of the nasals consonants: an abrupt change in the spectrogram at the time of the formation of the articulatory closure when the lips come together for /m/ or when the tongue touches the roof of the mouth for /n/. He also points out that after this closure there is less amplitude in the nasal consonant itself. Ladefoged (2006) also states that, usually, the nasal consonants have a low first formant at about 250Hz, as in the examples of Figure1. However, according to Ladefoged (2005) in the examples of Figure 2, the first formant of the nasal consonants is even lower (around 200Hz).

The author also states there is a variation on the location of higher formants, but, in general, there is a large region above the first formant with no energy (Ladefoged, 2006). In the examples given in the spectrograms form Figures 1 and 2, there is a weak second formant for each nasal just below 2000Hz and around 2500Hz respectively.

Another acoustic consequence which characterizes nasal consonants, as well as nasalized vowels, is the presence of antiformants (antiresonances) or zeros as well as formants (Fujimura & Erickson, 1997; Kurowski & Blumstein, 1995, Johnson, 2003). The articulation of nasal sounds creates antiresonances within the vocal tract. These antiresonances or antiformants are frequency regions in which the amplitudes of the source signal are attenuated because the nasal cavities absorb energy from the sound wave. The effects of these antiformants are more marked in nasal consonants than in nasal or nasalized vowels because consonants are articulated with a complete occlusion of the oral cavity.

Fujimura (1962) carried out a study in which he analyzed a number of samples of nasal murmurs occurring in various vowel contexts in order to locate the antiformants of the bilabial, alveolar and velar consonants. The speech materials consisted of a large group of nonsense utterances generated by three American English talkers. These utterances were all of the form /hə̀CVC/, that is., a stressed consonant-vowel-consonant syllable preceded by an unstressed syllable. In the case of syllables with /m/ and /n/, the initial and final consonants were identical. The consonant /ŋ/ occurred in final position only, in utterances of the form /hə̀rVŋ/). Five different stressed vowels were used for each of the syllables (/i, ɛ, æ, ɑ, u/). The experimental data were obtained with a computer, using an analysis-synthesis scheme. The author found a clear difference in the location of the antiformant (zero) for the bilabials and alveolars within non-overlapping frequency ranges. The antiformant was located between 750 Hz and 1250 Hz for [m] and between 1450 Hz and 2200 Hz for [n]. Since the zero for [ŋ] was above 3000 Hz, Fujimura characterized the nasals /m/, /n/, and /ŋ/ by low, medium, and high positions of the antiformant, respectively. These frequency ranges found by Fujimura (1962) have been confirmed and mentioned in recent studies (Harding & Meyer, 2003; Kurowski & Blumstein, 1995, 1987; Qi, 1989).

Fujimura (1962) also reports that the antiformant changed its position appreciably from word to word and also within the same utterance, depending on the change in the configuration of the oral cavity. The antiformant seemed to have a considerable influence on the formants in its immediate vicinity, but other formants within the frequency range of interest remained relatively constant, at least for the same speaker. Therefore, for the bilabial “the first and the fourth formants were almost invariant and the second and third formants with the antiformant formed a variable "cluster"” (p. 1871). For the alveolar, “the variable cluster consisted of the third and fourth formants and the antiformant, and the first, second, and fifth formants were relatively stable” (p.1871).

The author also claims that formant transitions of the adjacent vowels often play an important role in the variability of the formants of the nasal consonant. For instance, the frequency of the antiformant for /m/ was relatively high when the consonant preceded a front vowel such as /i/, and was lower when the context was a back vowel (Fujimura, 1962). This influence of vowel context in the production and in the perception of the nasal consonants will be closely discussed in the following chapter.

Another aspect, mentioned by Kurowski and Blumstein (1995), that also contributes to the acoustic complexity of nasal consonants is variation in the anatomical structure of the nasal cavities from speaker to speaker, which increases the degree of interspeaker variability. Therefore, it may be more difficult to identify consistent acoustic parameters and frequencies in nasal consonants that can be generalized across speakers (Gubtynowicz, LeGuennac & Mercier, 1985, cited in Kurowski & Blumstein, 1995, p.199).

2.2 Nasalization in English

In English, the nasal consonants /m/ and /n/ in word-final position are fully pronounced (O'Connor, 1992), with distinct places of articulation (Fujimura & Erickson, 1997). In fact, these nasal consonants are phonologically distinctive in word-final position, contrasting in minimal pairs such as *Tim-tin*. As explained by O'Connor (1992), the English nasal consonants /m/ and /n/ in word-final position are pronounced by lowering the soft palate and blocking the mouth as follows: for /m/ the mouth is blocked by closing the lips; whereas for /n/ the mouth is blocked by pressing the tip of the tongue against the alveolar ridge, and the sides of the tongue against the sides of the palate. Figure 3 shows the realization of the two English nasal consonants: bilabial /m/ and alveolar /n/ respectively.

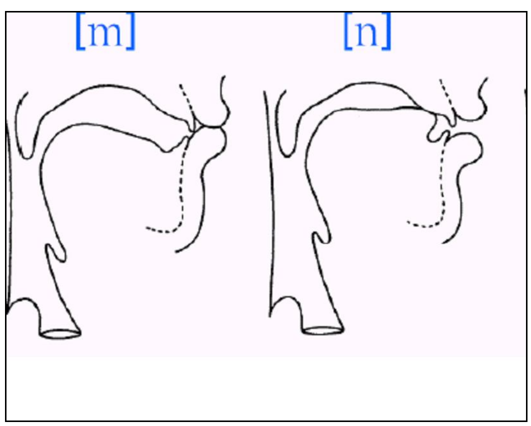

Figure 3. Realization of the English nasal consonants/ m/ and /n/ (**www.google.com.br**).

According to O'Connor, the pronunciation of neither of the sounds should cause much difficulty to most speakers. However, she also states that speakers of some languages, such as Portuguese, may have difficulty in pronouncing these nasal consonants in word-final position. O'Connor (1992) explains that "instead of making a firm closure with the lips or tongue tip so that all the breath goes through the nose, they may only lower the soft palate and *not* make a closure, so that some of the breath goes through the nose but the remainder goes through the mouth" (p. 65). When this happens the vowel that precedes the nasal consonant becomes nasalized.

The presence of nasalized vowels or consonants is spread over 99% of the world's languages (Chen et al., 2007), and this process of coarticulatory nasalization is extremely common. However, the degree of nasalization is different among languages, from subtle as in English (Giegerich, 1992; Hammond, 1999; Ladefoged, 2006) to strong as in Portuguese (Oliveira & Cristófaro-Silva 2005). It is important to state that although vowel nasalization can occur in English, there are no nasal vowels in this inventory (Giegerich, 1992), and nasalization of the vowel does not distinguish the meaning of English words (Ladefoged, 2005), so nasalization of vowels is not a distinctive feature.

2.3 Nasalization in Brazilian Portuguese

As stated by Mateus and d'Andrade (2000), the syllable-final nasal consonants are "one of the most challenging aspects of Portuguese" (p.130) due to the controversy that the sequence vowel plus nasal consonant causes. The problem concerns the nasal vowels: whether to consider them phonemes in opposition to the oral vowels (Head, 1964; Pontes, 1972; Back, 1973; all cited in Cristófaro Silva, 1999, p.165) or a combination of the oral vowel and the archiphoneme /N/ (Câmara Jr., 1971; Cristófaro Silva, 1999; Mateus & d'Andrade, 2000).

As stated by Cristófaro Silva (1999), in stressed position, there are seven oral vowels [i, e, ɛ, a, ɔ, o, u] and five nasal vowels [ĭ, ĕ, ă, ŏ, ŭ] in PB. According to some authors (Head, 1964; Pontes, 1972; Back, 1973; all cited in Cristófaro Silva, 1999, p.165), the five nasal vowels are added to the seven oral vowels; as a consequence, the BP vocalic inventory contains twelve vowels. According to these authors, minimal pairs such as *lá* [ˈla] – 'there' and *lã* [ˈlă] –'wool', and *mito* [ˈmitʊ] – 'myth' and *minto* [ˈmĭtʊ] – 'I lie' support the idea that the nasal vowels are opposed to the oral ones in BP.

On the other hand, Câmara Jr. (1971) argues that nasal vowels in BP are a combination of an oral vowel and the archiphoneme /N/, which nasalizes the preceding vowel and is reduced to a nasal element as in *lindo* [ˈlĩⁿdʊ] –'beautiful'. In this point of view, the nasal vowels are represented as /iN, eN, aN, oN, uN/. Cristófaro Silva (1999, p.92) states that the difference between a nasal segment [n] and a nasal element [ⁿ] is the time spent in the articulation. The articulation of a nasal segment takes longer than the articulation of a nasal element.

Mateus and d'Andrade (2000) similarly posit that there are no nasal vowels in Portuguese at the underlying level; instead they consider them sequences of "oral vowel plus nasal segment" (p.21). In order to support their hypothesis, the authors present the following arguments: (a) the pronunciation of /r/ after a nasal vowel is the strong /R/ as it is pronounced after a syllable-final consonant (e.g., *genro* [ˈʒĕRʊ] -'son-in-law'); (b) the phonetic realization of the prefix 'in' or 'im' before a consonant is pronounced as a nasal vowel [ĭ] (e.g., incapaz [ĭkaˈpaS] – ‘unable’) whereas when the prefix precedes a vowel it is realized as a vowel followed by a nasal consonant (e.g., [inakaˈbadʊ] – ‘unfinished’]. According to Mateus and d’Andrade (2000), these arguments seem to support the idea that, underlying, “Portuguese nasal vowels receive their nasality from a nasal segment that is deleted at the phonetic level” (p.23).

As stated by Wetzels (1997), in BP, a vowel followed by a nasal consonant can occur in stressed or unstressed syllable, in word-internal or word-final position. Table 1 shows some examples adapted from Wetzels (1997) and Monahan (2001). According to Monahan (2001), the examples below show the regressive assimilation of nasality to the preceding vowel and deletion of the nasal consonant which is present in the underlying form.

Table 1. Examples of vowels followed by nasal consonants regarding stress and syllable position in BP.

Surface Representation	Underlying representation	Spelling	Gloss
a. word internal stressed [fika]	/finka/	*finca*	‘fixes’
b. pretonic [ubígu]	/umbigo/	*umbigo*	‘navel’
c. word-final stressed [kupĩ]	/kupim/	*cupim*	‘termite’
d. word-final unstressed [íterĩ]	/interin/	*interin*	‘interim’

Baptista’s (1988a) theoretical/descriptive study of Portuguese nasalization analyzes the process of nasalization of the vowels according to the structuralist approach, the generative approach and the autosegmental approach. Baptista shows that only a non-linear approach to phonology can adequately account for the fact that there are different degrees of nasalization in Portuguese, although these varying degrees are not distinctive (p.87). Baptista based her analysis on the three degrees of vowel nasality proposed by Mateus (1975): (a) strong nasalization before a deleted nasal consonant as in *fim* - 'end'; (b) less strong nasalization before a nasal consonant assimilated to both the preceding vowel and the following consonant as *onde* – 'where'; (c) weak nasalization before a specified nasal consonant neither deleted nor assimilated as in *ano* – 'year'.

As reviewed above, nasalization in BP has provoked different views and theories. However, further discussion on those views regarding vowel nasalization is beyond the scope of the present study. Thus, for the purpose of this study, it is assumed that: (a) phonetically, the nasal consonants /m/ and /n/ are not fully realized after a vowel in word-final position and sometimes not realized at all; and (b) the vowel receives nasalization from the following nasal consonant (Cristófaro Silva, 1999; Mateus & d'Andrade, 2000; Câmara Jr., 1971). In English, vowels followed by nasal consonants are also nasalized (Giegerich, 1992), although the degree of nasalization in English is weaker than in BP and it is not a distinctive feature. Consideration of the differences in the way the word-final nasal consonants are pronounced in English and BP is very important to the understanding of the difficulties that the Brazilian learners of English may find in the identification of English word-final nasal consonants /m/ and /n/.

Chapter 3

Production and perception

This chapter is divided into three main sections: in 3.1 a brief review of studies carried out on the production of nasal consonants is presented; 3.2 reviews some studies on the perception of nasal consonants, and 3.3 presents some important issues regarding the use of visual cues in the in the perception of nonnative contrast.

3.1 Studies on Production of nasal consonants

As mentioned in the Introduction, a brief review of studies on speech production of the nasal consonants is of relevance as their findings have been used as background to studies on speech perception of the target consonants.

Regarding the production of the nasal consonants and their acoustic characteristics, this section discusses some variables which have been considered by researchers, such as syllable position (Kurowski & Blumstein, 1987; Repp, 1986; Repp & Svastikula, 1988), stress (Fujimura, 1962; Krakow, 1995), and vowel context (Kurowski & Blumstein, 1984, 1987; Krakow, 1995).

The purpose of two experiments carried out by Kurowski and Blumstein (1987) was to determine whether the acoustic properties of place of articulation of nasals could be derived for English labials and alveolars nasal consonants and to determine whether they remain stable across vowel context, speakers, and syllable positions. The objective of this study was based on previous results on the perception of place of articulation in nasal consonants which have suggested that perceptual cues to place of articulation reside in the integration of spectral properties in the vicinity of the nasal release incorporating both the murmur and the transitions (Kurowski & Blumstein, 1984; Repp, 1986).

In the first experiment, the speech tokens analyzed were spoken by three male speakers of English. Each utterance consisted of a nasal consonant (/m/ or /n/) in syllable-initial position (CV) followed by one of the vowels (/i, e, a, o, u/). In the second experiment, two speakers from Experiment 1 recorded syllable types consisting of a nasal consonant (/m/ or /n/) in syllable-medial position preceded by /s/ and followed by one of the vowels (/i,e, a, o, u/). In order to analyze the data from both experiments, the same procedures used in Kurowski and Blumstein (1984) were followed: the point of release or discontinuity between the nasal murmur and the transitions into the following vowel "was visually identified in the waveform as a break in the pattern of murmur pulses and the beginning of high-frequency components" (1987, p. 1920), and this was corroborated by spectral analysis using linear predictive coding (LPC). Using this method, the researchers were able to identify place of articulation in more than 89% of the tokens in Experiment 1 and in 84% of the tokens in Experiment 2.

Regarding vowel context effect, all misclassifications occurred in the context of front vowels in both experiments: while vowel context effects emerged for the labials in the environment of the front vowel [i] in Experiment 1, in the Experiment 2 vowel context effects emerged for the labials in the environment of the front vowels [i] and [e]. According to Kurowski and Blumstein (1987), the results of both experiments demonstrated that spectral patterns for nasal consonants are similar in at least two syllable positions (syllable-initial and syllable-medial position). However, the authors had difficulties when they tried to identify these spectral patterns for nasals in syllable-final position (VC) with the same methods used in CV syllables. They claimed that this failure may be related to the difficulty in locating the point of closure of unreleased nasal consonants (1987, p. 1924).

As reported by Krakow (1995, p.90), the phonetic and phonological evidence indicated that patterns of velic lowering and nasal assimilation are affected by the position of a nasal consonant in a word and thus, possibly in a syllable. The author also states that nasals consonants in word-final position are produced with greater and earlier velic lowering than nasal consonants in word-initial position, and likewise, nasal assimilation is more likely to affect vowels preceding word-final nasals than those preceding or following word-initial nasal. (Fujimura, 1990; Hendersen, 1984 all cited in Krakow, 1995, p. 90; Schourup, 1972).

Based on the findings for nasal consonant word-position, Krakow (1989, reported in Krakow, 1995, p. 90-91) conducted a study regarding production of the nasal consonants and their position in the syllable, which investigated syllable and word-based patterns of labio-velic coordination for bilabial consonants. The stimuli, recorded by two speakers of English, were designed to control segmental influences for the following comparisons: (a) word-initial versus word-final nasals (e.g., *hoe me* vs. *home E*); (b) syllable-final nasals in word-final versus word-medial positions (e.g., *home Lee* vs. *homely*); (c) word-medial nasals of unclear syllable affiliation versus. word-initial and word-final nasals (e.g., *homey* vs. *hoe me* and *home E*). The results showed that lip movements, related to the bilabial nasal consonant, were similar for the corresponding word-initial and word-final nasals. On the other hand, the results showed that the velic movements were different across the word-position manipulation. For the word-final nasal, the velum reached a lower minimum position.

The author reports two different and stable patterns related to the coordination between the lip and velum (regardless of the effect of segmental context and/or speaker): one related to word-initial nasals and the other to word-final nasals. That is, “the achievement of the velic target co-occurred with completion of lip raising for initial nasals but with initiation of lip raising for final nasals” (p. 93). Consequently, the vowel preceding the final nasal consonant was associated with significantly lower velic height than the vowel preceding the initial nasal consonant. As stated by Krakow (1995), this pattern supports the phonological evidence that vowels preceding nasal consonants in word-final position are more likely to be nasalized than vowels preceding nasal consonants in word-initial position (p.93).

As to stress and vowel context as variables in cross- language investigation of nasalization, Schourup (1972) reported a relation between stress and nasalization, that is, stressed vowels were more likely to become nasalized by assimilation than unstressed vowels. This relationship raised the question of whether velic movements for all vowels were similarly affected by stress. Therefore, Krakow (1995) conducted a study in order to address this question.

The data was collected from two participants producing sequences of words comparing velic positions for stressed and unstressed /i/ and /ɑ/ following and preceding a nasal consonant. The results for syllable with nasals in the initial position showed that inherent differences in velic height between /i/ and /ɑ/ were evident for both subjects in stressed and unstressed syllables: the velum was lower for /ɑ/ than for /i/ at all corresponding measurement positions. The results for the vowels preceding nasals in syllable-final position also showed that there were intrinsic differences in velic height between the two vowels: lower positions for /ɑ/ than for /i/. According to

Krakow (1995, p. 105), the results supported Schourup's claim that lower vowels are more likely to be contextually nasalized, stressed and precede a final nasal consonant.

In a theoretical article about nasal vowels written by Beddor (1995), she also mentions that vowel height influences the phonological development of vowel nasalization. As reported by her, the cross-linguistic data suggest that low vowels tend to distinctively nasalize earlier than non-low vowels, and high vowels tend to denasalize earlier than non-high ones (e.g., Chen, 1972 cited in Beddor, 1995, p. 185). She also points out that this preference for low vowel nasalization is in accordance with the perceptual findings that "low vowels tend to be perceived as more nasal than high vowels" (p. 185).

Concerning the production of English nasal consonants and their position in the syllable, specifically in syllable-final position by Brazilian learners, few studies have been carried out, to the best of my knowledge.

One of the few studies that investigates specifically the production of English coda nasals by Brazilian learners was carried out by Monahan (2001), which investigated the English interlanguage of Brazilian learners concerning processes such as regressive assimilation of nasality and nasal deletion in the coda position. Five native speakers of BP, who had lived the United States from four months to three years at the time they were tested, participated in the study.

Data was collected by means of a sentence reading task - 67 words with syllable-final nasal consonants in the carrier sentence *I will say ___ again,* and two paragraphs reading task with the nasal consonants in different phonological environments. Results showed heavy nasalization of the preceding vowels and, in most cases, there was very little or no evidence of the nasal consonant surfacing. Table 2 shows some examples:

Table 2. Surface representations of the nasal forms (Monahan, 2001, p. 24).

a. English	b. BP Interlanguage English	c. Gloss
[plæ̃nt]	[plæ̃t]	‘plant’
[klæ̃n]	[klæ̃]	‘clan’
[õw̃nz]	[õw̃z]	‘owns’
[ãw̃ns]	[ãw̃s]	‘ounce’

The author points out that a vowel followed by a nasal consonant in syllable-final position in English regressively assimilates its nasality, as occurs in BP. He states that the difference lies in the fact that in English the nasal consonant following the nasalized vowel is articulated (column *a*), whereas in BP the nasal consonant is deleted (column *b*) or reduced to a minimum. According to Monahan, the results show that BP speakers transfer the process of regressive assimilation of nasality and nasal deletion in the coda position into their English interlanguage.

Another study considering the production of English coda nasals by Brazilian learners was conducted by Baptista and Silva Filho (2006), who investigated the influence of markedness and syllable contact on the production of English final consonants in general, including nasals, by Brazilian learners. Concerning the nasal consonants, the results showed that two strategies were used by the participants to produce the English nasal consonants in syllable-final position – vowel nasalization/nasal deletion and paragoge.

A study conducted by Kluge (2004) investigated the production of English nasals /m/ and /n/ in syllable-final position by twenty pre-intermediate Brazilian EFL learners, by means of a sentence reading task. A perceptual analysis showed that in 38.66% of the data the nasals were not accurately produced. Similarly to Baptisat and

Silva Filho (2006), Kluge's study found that nasalization of the vowel combined with deletion of the nasal consonant was the most common strategy used in production.

Kluge (2004) also investigated the effect of preceding vowel (/ɪ, æ, ʌ, i/) and of length of the word, mono- or disyllabic, on the production of nasal consonants in syllable-final position. The results showed that among the four vowels in the study, the low vowels tended to cause more nasalization than the others. These results are consistent with those of Krakow (1995) for native speakers of English. As for length of the word, results showed that English syllable-final nasals were more accurately realized in disyllabic words. As suggested by Kluge, these results may be related to the fact that disyllabic words were usually followed by a consonant, which, in BP, causes a less strong degree of vowel nasality (2004).

Kluge also found that the alveolar nasal was more accurately produced than the bilabial, in both monosyllabic and disyllabic words. According to the author, this result may suggest that the participants associated the English words ending in "m" with the vowel nasalization/consonant deletion process in BP, as most word-final nasals in BP are written with the grapheme "m". English words ending in "n" seemed to have caused less association with BP.

In another study, Kluge (2007) investigated the production of English nasal consonants /m/ and /n/ in word-final position by ten intermediate BP learners of English by means of a sentence reading task. In each monosyllabic word, the nasal consonants could be preceded by the vowels /ɪ, ɛ, æ/, and could have three different environments: ending the sentence; followed by another word that started with consonants (/p, b, m, t, d, n, k, g/), and followed by a word that started with vowels /ɪ, ʌ, ə/. The results from a perceptual analyses revealed that the only strategy used by the participants when they did not fully realize the English word-final nasal consonants, was to nasalized the preceding vowel and deleted the nasal consonant, thus corroborating previous findings (Baptista & Silva Filho, 2006; Monahan, 2001; Kluge, 2004). As in Kluge (2004), results also showed that the nasal consonant /n/ was more accurately produced than /m/ in word-final position. Concerning the preceding vowel, statistical analyses showed no significant results for an effect of the preceding vowel for either /m/ or /n/. However, non-significant results indicated a slight tendency for the high preceding vowel to disfavor the accurate production of word-final /m/.

A study conducted by Becker (2007), analyzed acoustically the production of English /m/ and /n/ in word-final by ten pre-intermediate Brazilian teenagers' learners of English: five boys and five girls. Data was collected by means of a sentence reading task with a monosyllabic word containing either /m/ or /n/ in final position and either /æ/ or / ɪ / as preceding vowel inserted in a carrier sentence *I say* ____. Two Americans teenagers, a boy and a girl, also recorded the words, as a reference for comparison. The production of the American and the Brazilian participants was compared and the parameter defined as a reference for the comparison was the second formant of the nasal murmur. The results showed 54% of Brazilian girls' productions were similar to those of the native speaker, whereas only 26% of the boys' productions were similar to those of the native speaker. Results also indicated that the Brazilian learners of English could accurately produce the distinction between /m/ and /n/ in the context of the previous vowel /ɪ/.

3. 2 Studies on perception of nasal consonants

This section briefly discusses some relevant variables which have been considered by researchers with regard to the perception of nasal consonants, such as: role of nasal murmur and formant transition (Nakata, 1959; Nord, 1976 all cited in Kurowski & Blumstein, 1995; Malécot, 1956; Kurowski & Blumstein, 1984, 1995; Recasens, 1983), syllable position (Malécot, 1956; Kurowski & Blumstein, 1987; Qi, 1989; Ohde, Haley & Barnes, 2006) and vowel context (Kurowski & Blumstein, 1984; Sharf & Ostreicher, 1973; Repp, 1986),

One aspect that has been discussed regarding the perception of nasal consonants is the role of nasal murmur and transitions as perceptual cues to place of articulation. As reported by Kurowski and Blumstein (1995, p. 204), speech perception researchers for a long time assumed that the nasal murmur carried no perceptually salient information for place of articulation. Malécot (1956) conducted one of the first studies addressing this issue, considering both the murmur and the transitions as perceptual cues for place of articulation.

In this study, Malécot (1956) compared the relative weight of the murmur and transitions as cues of place of articulation in a series of tape-slicing experiments using natural speech. He examined the identification of the English nasal consonants (bilabial, alveolar and velar) in the context of the vowel /æ/ in three different conditions: (a) in unaltered syllable-initial and syllable-final position, (b) in syllable-initial and syllable-final position with steady-state vowels and murmurs without transitions, and (c) in isolated murmur from the three nasal consonants. Results showed that due to the lack of transitions, the twenty-five American listeners of this study had difficulty in correctly identifying the place of articulation of the nasal consonants. However, results also showed that their identification relying only on the murmurs or on the murmurs and the vowel was not entirely chance, especially in syllable-final position. Thus, Malécot was able to show that the murmurs had to contain at least some amount of place information and that this contribution was shown to be greater in post-vocalic than pre-vocalic position.

As reviewed by Kurowski and Blumstein (1995), after Malécot's study (1956), there were some other studies based on its findings (Nakata, 1959; Nord, 1976 all cited in Kurowski & Blumstein, 1995, p. 205; Recasens, 1983) in order to further investigate the role of the nasal murmur in the identification of nasal consonants. Those studies are briefly reviewed below.

Following Malécot's study, Nakata (1959, cited in Kurowski & Blumstein, 1984, p. 388 and in Kurowski & Blumstein, 1995, p. 205) carried out a study using synthetic speech about the same issue using a neutral murmur and varying formant transitions. From a given 70- and 30-ms murmur duration, results showed that /m/ was better identified with the longer murmur, whereas /n/ was better identified with the shorter murmur. The results seemed to indicate that perception of place of articulation in nasals varied as a function of the murmur duration.

Also following Malécot's study, Nord (1976, cited in Kurowski & Blumstein, 1995, p. 205) investigated the identification of Swedish nasal consonants preceded and followed by the vowel /a/. The results showed that the nasal murmur in syllable-final position carried more perceptual information for place of articulation than the nasal murmur in syllable-initial position, corroborating those of Malécot's study. As the results also showed that transitions played a greater role before the vowel, whereas nasal murmur did after the vowel, Nord concluded that the perceptual role of the nasal murmur and the transitions varied according to syllable-position.

Recasens (1983), also based on Malécot's study (1956), investigated the contribution of nasal murmurs and of formant transitions as place cues to the identification of nasal consonants. The researcher examined the identification of synthetic Catalan nasal consonants (alveolar, palatal, velar) after the vowel /a/ in syllable-final position by twenty-four Catalan listeners. In the synthesized stimuli, the murmur of the various nasal segments was combined with appropriate and conflicting transitions. In the first test, the murmur patterns were fixed and the transitions varied, whereas, in the second test, the transitions were fixed and the murmur patterns varied. The general results showed that, though transitions were more effective in providing cues for place of articulation than murmurs, the murmurs significantly contributed to the alveolar-velar distinction by the Catalans. From the results, Recasens concluded that both the murmur and transitions served as perceptual cues to place of articulation in nasal consonants, and that these cues played a reciprocal relationship as a function of place of articulation.

Based on the findings of two previous studies (Malécot, 1956; Recasens, 1983), Kurowski and Blumstein (1984) reexamined the role of the nasal murmur and the formant transitions in the perception of place of articulation. Five types of stimuli were generated from natural speech consisting of English labial and alveolar nasals followed by a vowel /i, e, a, o, u/: (a) full murmurs, (b) transitions plus vowel segments, (c) the last six pulses of the murmur, (d) the first six pulses of the transitions plus vowel segments, (e) the six pulses surrounding the nasal release (the last three pulses of the murmur and the first three pulses of the transitions). Ten native speakers of English took the forced-choice identification test and they had to choose from the set "B D M N" the consonant they heard. The results showed that both the transitions and the murmur provided information for the accurate identification of place of articulation for the nasal consonants. Results also revealed that the participants obtained higher scores in the last condition, that is, in the one containing pulse of the murmur and of the transitions. Based on the results, Kurowski and Blumstein (1984, p. 388) concluded that neither the murmur nor the transitions alone may be a sufficient cue for place of articulation. They also claimed that the murmur and transitions are not separate cues but rather integrated by the auditory system into one unitary representation.

One important issue raised by Ohde, Haley and Barnes (2006) is the fact that perceptual research on cues to place of articulation identification for nasal consonants has been based, primarily, on studies with the nasal consonant in syllable-initial position. The authors state that significantly less is known about variations in the perception of nasals in syllable-final position. However, Ohde and co-workers (2006) affirm that there is evidence indicating that the perceptual identification of consonants is more accurate (Redford & Diehl, 1999, all cited in Ohde, Haley & Barnes, 2006; Repp & Svastikula, 1988;) and acoustic properties more robust (Ohala, 1990; Manuel, 1991; Wright, 2001, all cited in Ohde, Haley & Barnes, 2006) in CV syllables than in VC syllables.

According to these authors and some others (Malécot, 1956; Kurowski & Blumstein, 1987; Qi, 1989), there are many factors which make it difficult to predict the perceptual role of acoustic properties in nasal consonants in syllable-final position from research carried out with nasal consonants in syllable-initial position, such as: (a) the transition between the vowel and murmur in VC syllables is not as abrupt as the murmur and vowel transition in CV syllables (Kurowski & Blumstein, 1987); and (b) as nasal consonants are produced similarly to their homorganic oral stops, it is reasonable to predict that formant transitions for nasals in syllable-initial position would be less distinctive than formant transitions in syllable-final position.

A recent study carried out by Ohde and colleagues (2006) investigated the contribution of the nasal murmur and vocalic formant transition to the perception of the /m/ and /n/ distinction by ten adult English listeners. This contribution of the nasal murmur was investigated for speakers of different ages in both consonant-vowel and vowel-consonant syllables in two experiments. The first experiment investigated the perceptual distinction of /m/-/n/ in syllable-initial position. The speech sample material consisted of syllables with nasal consonant (bilabial or alveolar) followed by a vowel ([i, æ, u, ɑ]) produced by three male adults, three female adults, and three children (three, five and seven years old). Each syllable production was edited into eight segment types: (a) full murmur, (b) the last 50 ms of the murmur, (c) the last 25 ms of the murmur, (d) the last 25 ms of the murmur and the first 25 ms of the immediately following vowel, (e) the first 25 ms of the vowel, (f) 50ms transition – the first 50 ms of the vowel, (g) full transition, and (h) full syllable. The participants (10 graduate students, native speakers of English) were instructed to respond to each stimulus by identifying the nasal consonant in a two-alternative forced-choice test. Results showed that the mean whole syllable identification ranged from 95% for speech produced by 3- and 5-year old children to 99% for speech produced by adult females and males. Whole syllable identification for speech produced by the 7-year child was 97%. Across speaker groups, the results showed that a segment including the last 25 ms of the murmur and the first 25 ms of the vowel yielded higher perceptual identification of place of articulation than any other segment in syllable-initial position.

The second experiment investigated the perceptual distinction of /m/-/n/ in syllable-final position. The stimuli consisted of syllables with one vowel ([i, æ, u or ɑ]) followed by a nasal consonant (/m or n/) produced by the same speakers of Experiment 1. The following eight segment types were generated from each syllable: (a) full transition – from syllable onset to the discontinuity between the vowel and the murmur including the quasi-steady-state of the vowel and the formant transition, (b) the last 50 ms of the vowel, (c) the last 25 ms of the vowel, (d) the last 25 ms of the vowel and the first 25 ms of the murmur, (e) the first 25 ms of the murmur, (f) 50 ms transition – the first 50 ms of the murmur, (g) full murmur, and (h) full syllable. The participants, 10 graduate students who did not participate in the Experiment 1, followed the same procedures as in the previous experiment. The results showed that the mean whole syllable identification ranged from 86% for speech produced by the 3-year old to 98% for speech produced by adult males. Whole syllable identification was 93% for speech produced by the 7-year old and 94% for speech produced by the 5-year old and female adults. The analysis of speaker groups showed that the murmur transition stimulus was not the dominant cue for identification of place of articulation of nasals in the VC context. For all speaker groups, identification of nasals was significantly more accurate from the whole syllable than from the murmur transition segment and from any of the transition segments. By comparing the identification of the nasal consonants in syllable-initial and syllable-final position, Ohde, Haley and Barnes (2006) concluded that: (a) consistently more accurate identification of the nasals occurred for adult in CV syllable than in VC syllable; (b) the same general trend was found for children speaker groups; (c) identification of the nasal from the transition cue was generally more accurate in CV syllables than in VC for both adult and child speaker groups; (d) murmur transition segment resulted in accurate and stable perception across talkers when segmented from CV syllables, but resulted in substantial perceptual variability when extracted from VC syllables.

With reference to vowel context, Kurowski and Blumstein (1995) state that few studies had investigated the influence of vowel context on the perception of nasal consonants regarding place of articulation either in syllable-initial (Sharf & Ostreicher, 1973; Kurowski & Blumstein, 1984; Repp, 1996) or syllable-final position (Zee, 1981, cited in Kurowski & Blumstein, 1995, p. 199) by native speakers of English.

Sharf and Ostreicher (1973) investigated the perceptual effects of forward and backward coarticulation across syllables boundaries by 37 female American listeners. As for the identification of the bilabial and alveolar nasal consonants followed by a vowel, either /i/ or /u/, the results showed that /m/ was significantly more identified before /u/ than before /i/, whereas /n/ was identified significantly more often identified before /i/ than before /u/.

Kurowski and Blumstein (1984), investigating the role of the nasal murmur and the formant transitions in the perception of place of articulation of the English nasals consonants, also reported results for the influence of vowel context. Ten native speakers of English took a forced-choice identification test in which they had to indentify the nasal consonants /m/ and /n/ followed by one of the vowels /i, e, a, o, u/. The results regarding vowel context showed that it was more difficult for the participants to identify both nasal consonants before /i/ than before the other vowels /e, a, o, u/ in the condition containing both murmur and transitions information of the nasal consonants.

Repp (1986) investigated the contribution of the nasal murmur and the vocalic formant transitions to perception of English /m/ and /n/ in syllable-initial position followed by /i, a, u/. The participants of this study were 10 native speakers of American English and one native speaker of Russian and one of Chinese who were fluent in English. According to the researcher, the results of the nonnative speakers did not differ systematically from those of the native speakers. Regarding vowel context, results showed that, in general, it was more difficult for the participants to identify the nasal consonants before /i/ than before /a/ and /u/, corroborating the results of Kurowski and Blumstein (1984).

Zee (1981, cited in Kurowski & Blumstein, 1995, p. 199) investigated the effect of vowel quality on the perception of post-vocalic nasal consonants (labials, alveolars and velars) in white noise (i.e., noise within a wide range of random frequencies of uniform intensity, inserted to make the task more difficult) by native speakers of English. The results showed that labials were often incorrectly identified as alveolars after the front vowels /i/ and /e/, and velar nasals tended to be perceived as alveolars after the high front vowel /i/.

As reported by Kurowski and Blumstein (1995), the same vowel context effect for the identification of bilabials in the environment of /i/ and /i, e/ found in the studies reviewed above were also found with other consonant classes such as the stop consonants (Kewley-Port, 1983, cited in Kurowski & Blumstein, 1995, p. 199, Blumstein & Stevens, 1980).

Regarding perception of nonnative nasal consonants, few studies have been conducted, to the best of my knowledge. Hansberger (2000, 2001a, 2001b) carried out cross-language studies in which he investigated the perception (discrimination and/or identification) of nonnative nasal consonants by native speakers of different languages, such as: Malayalam, Marathi, Punjabi, Tamil, Oriya, Bengali, and American English.

Malayalam is a Dravidian language spoken primarily in the state of Kerala in India. Tamil is also a Dravidian language spoken primarily in southern India and Sri Lanka, while Marathi, Punjabi, Oriya and Bengali are all Indo-Aryan languages. The native languages of the listeners were chosen to represent three different types of nasal consonant phonemic inventory presumed to be relevant for the perception of the Malayalam series (bilabial, interdental, alveolar, retroflex, palatal and velar): (a) dental-retroflex phoneme group (Marathi and Punjabi); (b) alveolar-retroflex group (Tamil and Oriya); and (c) alveolar group (Bengali and American English).

The author states that he chose nasal consonants as stimuli because they were predicted to be a perceptually challenging set for some or all of the nonnative listener groups, particularly the coronal nasal series from Malayalam language, which has the richest set of coronal nasal consonants from an easily accessible linguistic community and provides a large set of nasal consonants varying in place of articulation. Hansberger (2001a) states that "nasal consonants varying in place of articulation have been shown to be confusable relate to other contrast" (p.308). He also points out that nonnative sounds that are very confusable may elicit considerable cross-language differences in perceived similarity that "would not be predictable from abstract description of listener's language, based on units as the phoneme or allophone" (2001a, p. 308).

Perception was assed by means of an identification test (Hansberger, 2000, 2001b) and an AXB discrimination test (Hansberger, 2001a, 2001b). For the identification test, native speakers of Malayalam, Marathi, and Oriya recorded a list of real and nonsense words from their L1, in which the target nasals appear in all syllable position allowable by the individual languages, in [a], [i] or [u] vocalic context. For the discrimination test, native speakers of Malayalam recorded the stimuli used in the AXB test: two tokens of each nasal consonant type, appearing in isolated words in one vocalic context ([i]) and one syllabic context (VCV). The two perception tests have different vocalic context either preceding or following the nasal consonant, and the presence of the nasal consonant in different syllable-positions. However, Hansberger does not consider these variables in the analysis of the perception of the nasal consonants by the participants in any of his three studies.

Results of the identification test (Harnsberger, 2000) showed that labeling and rating of nonnative stimuli were conditioned by a degree of language-specific phonetic detail that corresponds to perceptually relevant cues to native language contrasts (p.764). A multidimensional scaling (MDS) analysis of the similarity scores of the discrimination test (Harnsberger, 2001, p. 322) revealed substantial effects of linguistic experience on the organization of perceptual space that cannot be accounted for by abstract units such as phonemes or allophones. According to the author, the seven listener groups could be regrouped in terms of their arrangement of nasals in the perceptual space according to attributes that are quite independent of their phonemic or allophonic inventory, such as the overall dispersion of nasals, different patterns of clustering of nasals (interdental-alveolar-retroflex-palatal-velar), and the similarity observed between the bilabial and retroflex nasals (p. 322).

Aoyama (2003) conducted two experiments in which she investigated the perception of syllable-initial and syllable-final nasals in English by Korean and Japanese listeners. In both Korean and English, /m/ and /n/ contrast in syllable-initial position and /m/, /n/ and /ŋ/ contrast in syllable-final position. In Japanese, however, /m/ and /n/ contrast in syllable-initial position, whereas nasals do not contrast in syllable-final position. In the first experiment, Aoyama investigated Korean and Japanese listeners' perception of L2 segments and found that Japanese listeners had significant difficulty distinguishing the syllable-final velar nasal (/ŋ/) from the alveolar (/n/), although they had no particular problems distinguishing the final bilabial nasal /m/ from either the velar /ŋ/ or the alveolar /n/.

In the second experiment, Aoyama examined the perceived relation between English /m/, /n/ and /ŋ/ and the Japanese categories in order to investigate why it was particularly difficult for the Japanese listeners to distinguish syllable-final /n/ from /ŋ/. The experiment showed that syllable-final /m/ was assimilated to one Japanese category, while two or more categories were used to classify /n/ and /ŋ/. Aoyama concludes that the results of both studies show that "perceptual difficulties in an L2 cannot be predicted simply from the comparison of phoneme inventories between learners' L1 and L2, and suggest that the perceived relationship between L1 and L2 segments plays an important role in how L2 segments are perceived" (p.263).

With regard to perception studies, to the best of my knowledge, Kluge's studies (2004, 2007) are the only ones which dealt with Brazilian learners of English concerning perception of English nasal consonants in word-final position. In the first study, Kluge (2004) investigated the perception of word-final nasals /m/ and /n/ by twenty pre-intermediate Brazilian learners of English. A group of three native speakers of American English, who had lived in Brazil for an average of nine months by the time of data collection, also took the perception tests as a reference for comparison. Perception was assessed through a Categorial Discrimination Test (adapted from Flege, Munro & Fox, 1994) and a Native-like versus Nonnative-like Identification Test in which the participants had to indicate which of the two pronunciations they heard was more nativelike than the other, or whether either the two or neither of them was nativelike.

The results revealed that less than half of the Brazilian participants accurately perceived the nasal consonants in word-final position, 44% in the CDT and 44.5% in the identification test. The native listeners also seemed to have some difficulty, although to a much lesser degree: they accurately perceived the target nasal consonants in 78.3% in the CDT and 75.8% in the identification test. Results for the Native-like versus Nonnative-like Identification Test also showed the Brazilian participants better identified the native-like pronunciation when it was presented in contrast to the nonnative-like pronunciation.

Kluge (2004) also investigated the influence of preceding vowel in the accurate discrimination/identification of English word-final nasals in both perception tests. The results revealed that the preceding vowel of the study (/ɪ, æ, oʊ, eɪ, ʌ/) seemed to influence the accurate perception of the target nasals /m/ and /n/ by the Brazilian learners and the native speakers. Both groups seemed to have difficulties, although to different degrees, in either discriminating or identifying the target nasals in the context of high vowels, whereas low vowels seemed to favor the accurate perception of English coda nasals. The results for high vowels for the nonnative speakers were consistent with those found by Sharf and Ostreicher (1973) and reviewed by Kurowski and Blumstein (1995) for native speakers of English.

In the second study, Kluge (2007) investigated the perception of word-final nasals /m/ and /n/ of ten intermediate Brazilian learners of English assessed by means of a Native-like versus Nonnative-like Identification Test (based on Kluge, 2004). Results for the Native-like versus Nonnative-like Identification Test showed the

Brazilian learners of English were better able to identify the native-like pronunciation of either word-final /m/ or /n/ when it was presented in contrast to a nonnative-like pronunciation, corroborating those results of Kluge, 2004. Though all the words with either /m/ or /n/ in word-final position used in the identification test were preceded by either /ɪ/, /ɛ/ or /æ/, Kluge (2007) did not investigate the effect of the preceding vowel in the accurate identification of the native-like realization of the nasal consonants.

3.3 Use of visual cues in the perception of nonnative contrast

As stated by Rosenblum (2005), “it is becoming increasingly clear that human speech is a multimodal function, usually apprehended by visual (lipreading) as well as auditory (hearing) means” (p.51). Summerfield (1992) claims that lipreading is helpful to all sighted people, with normal or impaired hearing, as it compensates rather specifically for the insufficiencies of audition (p. 71). Thus, the speech signal contains multiple acoustic cues to phonetic features and such redundancy of information helps listeners with good hearing in their L1 in many contexts, such as degradation of the signal by noise (Sumby & Pollack, 1954); and also help listeners with hearing loss problems (Grant & Seitz, 1998a, 1998b).

Concerning blind children, a study conducted by Mills (1987, cited in Schartz, Abry, Boë & Cathiard, 2002, p. 264) showed that visual speech input plays an important role on their L1 acquisition. As reported by the authors, research with German, Russian and English blind children has shown that it was difficult for them to learn an “easy-to-see and hard-to hear contrast” such as the nasal consonants /m/ and /n/ (Schartz et al., 2002, p. 264).

Grant and Seitz (1998b) define “AV benefit” as the amount of benefit resulting from a combination of auditory and visual cues (p. 2438), and this term has been used to describe the advantage of an audio-visual presentation. However, the AV benefit may depend on the relative perceptual weighting of visual and auditory cues (Hazan, Sennema, Faulkner, Ortega-Llebaria, Iba & Chung , 2006, p. 1741). One way of evaluating this perceptual weighting is the McGurk effect, which was introduced by McGurk and MacDonald (1976).

In their study, McGurk and MacDonald (1976) investigated audiovisual perception of speech stimuli with conflicting cues. For the stimuli, a woman was filmed while she repeated CV syllables (with interval of 0.5 s) with a stop consonant (/p, b, k, g/) followed by the vowel /a/ (e.g., [papa], [baba], [kaka], [dada]). The audio stimuli were dubbed with different consonants in four combinations as follows: (a) ba-audio /ga-video; (b) ga-audio/ba-video; (c) pa-audio/ka-video; and (d) ka-audio/pa-video. The participants (21 pre-school children, 28 primary school children and 54 adults) were individually tested in two conditions (*Audio/Video* and *Audio only*) and were instructed to repeat what they heard in these conditions.

Results for the *Audio only* condition showed high averages of accurate identification for all the participants - 91% for pre-school children, 97% for primary school children and 99% for adults. However, results for the *Audio/Video* showed that errors were substantial as the average error rate was 59% for pre-school children, 52% for primary school children and 92% for adults (p. 746-747). Results showed that stimuli with conflicting cues such as auditory [baba] and visual [gaga], and auditory [papa] and visual [kaka] were perceived by the participants as [dada] and [tata], respectively, not corresponding to either the auditory or the visual stimulus. Results also showed that some other stimuli, such as auditory [gaga] and visual [baba], was perceived by the participants as [gabga] or [bagba], combining both the auditory and the visual stimuli. These results found by McGurk and MacDonald (1976) suggest that information from auditory and visual modalities are integrated and influence speech perception.

Taking into consideration the McGurk effect, cross-language studies have suggested that this effect is different for listeners from different language backgrounds. For instance, research has shown that this effect is weaker for Japanese (Sekyiyama & Tohkura, 1991, 1993; Hayashi & Sekyiyama, 1998) and Chinese listeners (Sekyiyama, 1997; Hayashi & Sekyiyama, 1998) than for English or Spanish listeners (Massaro, Tsuzaki, Cohen, Gesi & Heredia, 1993). Moreover, a study carried out by Hayashi and Sekyiyama (1998) suggests that the McGurk effect is stronger for foreign speech stimuli than for native stimuli by Japanese speakers.

Based on the findings of the McGurk effect, recent studies have investigated the role of visual cues as a variable to investigate the perception of either L1 or L2 contrasts. As for the perception of L1 contrasts, there are some studies such as: (a) Traunmüller and Öhström (2004, 2007), investigating Swedish vowels; (b) Sekiyama & Tohkura (1991), investigating Japanese syllables; and (c) Massaro, Cohen and Smeele, (1996), investigating English CV syllables. Regarding the perception of L2 contrasts, there are some studies such as: (a) Hayashi and Sekiyama (1998), investigating Chinese and Japanese syllables by Chinese and Japanese speakers; (b) Hazan et al., (2006), investigating English consonants by Spanish and Japanese speakers; and (c) Hardison (1999), investigating English CV syllables by Japanese, Korean, Spanish and Malay speakers. In general, studies have found that both L1 and L2 listeners rely on visual information on the identification of L1 and L2 contrasts, respectively.

Concerning the effect of visual cues, some recent studies have investigated the role of visual cues in perceptual training studies with L2 contrasts (Hardison, 2003, 2005; Hazan et al., 2005). Results have shown that: (a) perceptual training with auditory and visual information is more effective than training with only auditory information (Hardison, 2003, 2005); and (b) *Audio/Video* training is more effective than *Audio only* training when the contrast is sufficiently salient (Hazan et al., 2005).

The research carried out by Hazan, and coworkers (2006) on the use of visual cues in the perception of a nonnative contrast is particularly relevant to the present study because it deals with perception of consonants and contains a detailed description of the method used to assess perception. In their study, Hazan et al. investigated the effect of visual salience by evaluating the perception of two English phonemic contrasts differing in the visual distinctiveness of their articulatory gestures: the highly distinctive contrast between labial (/b/-/p/) and labiodental (/v/) consonants (Experiment 1), and the less visually distinctive contrast between /r/ and /l/ (Experiment 2). Both contrasts were tested with Spanish and Japanese learners of English and also with a group of native-speakers of English.

The participants were tested in three different conditions: a) Video alone (*V*), (b) Audio only (*A*), and (c) Audio-visual (*AV*). Results of Experiment 1 showed that both learner groups achieved higher scores in the *AV* than in the *A* test condition for the highly distinctive contrast, showing evidence of audio-visual benefit. Regarding Experiment 2, results showed that neither group showed evidence of audio-visual benefit for the less visually distinctive contrast. Based on the performance of both learner groups and on the performance of the native speakers of English, Hazan et al. (2006) state that visual salience has an impact on the perception of visual cues to consonant contrasts in both native and nonnative languages, as both native speakers and

L2 learners of English achieved much poorer scores in the *V* condition for the less salient /l/-/r/ contrast than the highly salient labial/labiodental contrast, for which near-perfect perception was achieved in the *V* condition for native speakers and even some Spanish-L1 learners of English (p. 1749).

Based on Hazan et al.'s study (2006), Kluge (2007) investigated the use of visual cues in the perception of English word-final nasal consonants by Brazilian EFL learners in a pilot study. This was the first study investigating this variable with Brazilian EFL learners, to the best of my knowledge. Kluge examined the identification of word-final nasals /m/ and /n/ by ten intermediate Brazilian learners of English assessed by means of a Three-condition Identification Test. In this test, the monosyllabic words with either /m/ or /n/ in word-final position, produced by a native speaker of English, were presented in three different conditions (a) *Audio only*, in which the participants could only hear the realization of a word; (b) *Audio/Video*, in which the participants could hear and see the realization of a word; and (c) *Video only*, in which the participants could only see the realization of a word. The participants were asked to indicate which of the two nasal consonants they heard and/or saw.

Results showed that the *Audio/Video* condition seemed to favor the accurate identification of both word-final nasal consonants when compared to the *Audio only* condition. Results also showed a slight tendency for the *Audio only* condition to disfavor the accurate identification of both bilabial and alveolar nasal consonants compared to the *Audio/Video* condition. In general, results indicated that the Brazilian participants seemed to benefit from the *Audio/Video* presentation as discussed by Grant and Seitz (1998b), in the accurate identification of English word-final /m/ and /n/. These results also seem to in the direction of those of Hazan et al. (2006) and suggest that Brazilian learners of English benefited from the *Audio/Video* presentation as the bilabial/alveolar contrast investigated in the pilot study is a visually distinctive contrast.

In this pilot study, Kluge (2007) also investigated the effect of preceding vowel in the identification of the target nasals in the Three-condition Identification Test by the Brazilian participants. However, due to limited number of tokens, she analyzed this variable considering all three conditions tested. Results showed that, among the preceding vowels of the study (/ɪ, ɛ, æ/), the low previous vowel favored the identification of the English word-final nasal /n/, whereas the high previous vowel disfavored the accurate identification of /m/ in word-final position. Just as in Kluge (2004), results for high preceding vowels for the nonnative speakers were consistent with those found by Sharf and Ostreicher (1973) and reviewed by Kurowski and Blumstein (1995) for native speakers of English.

Chapter 4

Speech perception models

This chapter briefly reviews two models of speech perception: the Speech Learning Model (SLM) proposed by Flege (1995), and the Native Language Magnet (NLM) model proposed by Kuhl (1991, 1993).

4.1 The Speech Learning Model

As pointed out Flege (1995), foreign accent is a widespread phenomenon among nonnative speakers. Listeners perceive accented speech when they “detect divergences from English phonetic norms along a wide range of segmental and suprasegmental (i.e., prosodic) dimensions” (p.233). As reviewed by Flege (1995, p.234), different explanations for the cause of foreign accent have been proposed, such as: (a) neurological maturation, which might reduce neural plasticity (Penfield, 1965; Lenneberg, 1967, all cited in Flege, 1995), leading to a diminished ability to add or modify sensorimotor programs for producing L2 sounds; (b) inaccurate perception of sounds in an L2 (Rochet, 1995; Best, 1995; Kuhl & Iverson, 1995); (c) inadequate phonetic input, insufficient motivation, psychological reasons for keeping the foreign accent, or the establishment of incorrect habits in early stages of L2 learning (Flege, 1988). Some other explanations have been proposed, including attitudinal and psychosocial factors, however the actual cause of foreign accent remains debatable (Flege, Munro & MacKay, 1995). Among the mentioned reasons for foreign accent, the present study is related to explanation (b), that is, to the capacity to accurately perceiving L2 speech sounds.

Flege (1995) argues that L2 speakers may interpret L2 sounds "through the grid" (Wode, 1978, cited in Flege, 1995) of their L1. This fact, "virtually ensures that nonnative speakers will perceive at least some L2 vowels and consonants differently than do native speakers" (Flege, 1995, p. 237).

Flege's Speech Learning Model (1995) is concerned with ultimate achievement in L2 pronunciation, a fact that the model claims to be related to the pattern of speech perception L2 listeners present. In fact, it declares that misperception is the major reason for inaccurate segmental production. However, the model proposes that the possibility to acquire a new sound system is continuously present and can be applied to L2 acquisition. The SLM consists of four postulates which, in turn, generate seven hypotheses. Whereas all postulates (P) are relevant to the present study, hypotheses 1, 2, 3, and 5 are of particular importance, as they deal with the relationship between L1 and L2 speech sounds. The postulates and hypotheses (H) are described by Flege (1995, p. 239) as follows:

Postulates

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

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

P3 Phonetic categories established in childhood for L1sounds evolve over the life span to reflect the properties of all L1 or L2 phones identified as a realization of each category.

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

Hypotheses

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

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

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

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

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

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

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

According to the model, the development of new categories for L2 sounds would be affected by two major variables: age of learning and perceived cross-language phonetic distance. With reference to the last variable, it is hypothesized that "the greater the perceived difference of an L2 sound from the closest L1 sound, the more likely that a separate category will be established for the L2 sound" (Flege, 1995, p. 264). It is noteworthy that this hypothesis is closely related to the perception model that will be described next (section 4.2), the Native Language Magnet model.

The SLM claims that phonetic category formation might be "blocked by the mechanism of equivalence classification" (Flege, 1995, p. 239). Equivalence classification is defined by Flege (1996) as "a basic cognitive mechanism thought to shape both L1 and L2 speech learning" (p.13). The mechanism of equivalence classification is important in the process of native-language learning as it enables young children to detect phones produced by different speakers, or in different phonetic contexts, as being part of the same category (Flege, 1987). However, Flege hypothesizes that equivalence classification “may lead to foreign accent in older children and adults by preventing them from making effective use of auditorily accessible acoustic differences between phones in L1 and L2” (p. 50).

The concept of equivalence classification determines the categorization of the L2 phones as *identical*, *similar* or *new* in relation to the L1 phones. Wode (1995, p.323) describes L2 *identical, new* and *similar* phones as follows: (a) *identical* phones are dealt by pre-existing categories; (b) *similar* L2 sounds are those that are perceived through the pre-existing categories, and are thus easily and quickly acquired, although they tend to undergo transfer of phonological features of the L1 category, and (c) *new sounds* are those which do not exist in the original sound system of the speaker; and because the perceptual space of this sound is not occupied by any categories, the establishment of the new category tend to be successful, though it might take some time.

According to the SLM, L2 sounds “may be at first identified in terms of a positionally defined allophone of the L1” (Flege, 1995, p. 263). However, as L2 learners gain experience, they may become able to discern phonetic differences between L2 sounds and their closest L1 counterparts. In this circumstance, a phonetic category representation may be established for the new L2 sound (Flege, 1995).

To conclude, the SLM posits that the perceived relationship between categories in L1 and L2 plays an important role in accurately perceiving or producing L2 sounds. The model hypothesizes that L1 and L2 sounds are “related perceptually to one another at a position-sensitive allophonic level” and acquisition of L2 sounds depends on the perceived dissimilarity between L1 and L2 sounds (Flege, 1995, p. 239).

Thus, considering the SLM and the characteristic “position-sensitive” allophonic representation and realization of the nasals /m/ and /n/ in word-final position in English and BP, one could expect that Brazilian learners of English (a) would struggle to identify the phonetic dissimilarities between L1 and L2 sounds; and (b) the mechanism of equivalence classification may block accurate perception of the nasals in the L2.

4.2 The Native Language Magnet model

The Native Language Magnet (NLM) model (Kuhl, 1991, 1993; Williamns, Lacerda, Stevens & Lindblom, 1992; Kuhl & Iverson, 1995) is based on the key concept that speech categories exhibit certain internal structures that propitiate a sound to be perceived as the best exemplar—or prototype—of a phonetic category. Such internal structures would allow a prototypic member of a phonetic category to be "more quickly encoded" and "more durably remembered" (Kuhl, 1991, p. 93) than any other phonetic exemplar.

The model claims that speech perception is an innate ability and that the establishment of prototypes is a consequence of linguistic experience, which would allow L1 speakers to develop phonetic mental representations of L1 speech sounds since the first days of life. In a series of experimental data, Kuhl and colleagues have demonstrated the ontogeny and phylogeny of prototypes and their role on speech perception, either in L1 or in L2, experiments that will be reviewed below.

Kuhl (1991) aimed at investigating "the nature, function, development, and species specificity of speech prototypes" (p. 94) in L1. In order to answer the four proposed questions, she designed a series of 4 experiments with the participation of three types of listeners: adults, infants and monkeys.

In experiment 1 the addressed question concerned how adult speakers would rate different exemplars of the same vowel category /i/ (prototypic and nonprototypic). She found that adults consistently assigned different category goodness ratings for the 64 /i/ vowel stimuli, the prototypic categories receiving higher ratings than the nonprototypic ones. For experiment 2, Kuhl analyzed whether (non)prototypicality affects adults' perception of the vowel. The rationale was that if prototypes are in fact internally structured, this structure would affect the perception of the other phonetic members of the same category. She used the same set of 64 stimuli of experiment 1 in a discrimination test, but now presented each testing referent, prototype and nonprototype categories, in two separate sets of 32 surrounding members each. The findings showed that prototypicality does affect adults' perception of within-category vowel differences. In other words, she found that members close to the prototype were perceived as more similar to other members of this category than members close to the nonprototype—evidence that internal structures do affect the organization of the speech category. At this point Kuhl hypothesizes that prototypes behave like perceptual 'magnets' that attract the surrounding categories so that the perceptual space seems to be shrunk around them.

In order to further examine the behavior of prototypes as magnets, she carried out experiment 3, in which the same basic procedures of experiment 2 are replicated with 6-7 month-old infants. The rationale was that prototypes would really work as magnets if language-inexperienced subjects mirrored adults' responses, that is, if infants were able to greater generalize to novel phonetic within-categories from prototypes than from nonprototypes. Kuhl found that infants did duplicate adults' results and, for the first time, referred to prototypes as perceptual magnets. She then inferred that this perceptual magnet effect is inherently human, and to answer her hypothesis she conducted experiment 4 with monkeys.

This fourth experiment also replicated the basic methods and procedures of experiments 2 and 3 and found that monkeys' perception was not affected by the prototype—generalization around the prototype and the nonprototype was the same. She concludes that, although humans and monkeys are able to perceive speech sounds categorically, the perceptual magnet effect is an inherent human capacity. Kuhl concludes this study (1991) claiming that the perceptual magnet effect can account for findings in L2 speech perception such as the fact that by the age of 10-12 months children are no longer able to discriminate differences between L2 sounds that they could detect earlier in life. That is, by the age of 6 months infants seem to have already tuned their speech perceptual systems into their L1.

To sum up, the author not only concludes that the magnet effect is inherently human, but also suggests that it is strongly affected by linguistic experience, a hypothesis that would be later confirmed by her own and her co-workers' studies, (Kuhl, 1991; Kuhl, Williamns, Lacerda, Stevens & Lindblom, 1992; Kuhl, 1993; Kuhl & Iverson, 1995; Kuhl, 2000; Kuhl, Conboy, Coffey-Corina, Padden, Rivera-Gaxiola & Nelson, 2008), which will be reviewed below.

In their 1992 study, Kuhl and colleagues provided evidence that children shift from language-universal perception to language-specific perception much earlier than previous studies have suggested (Werker & Tess, 1984; Werker & Lalonde, 1988; cited in Kuhl et al, 1992, p. 606, Werker & Polka, 1993). These studies suggested that this shift is due to linguistic experience that would permit 10-12 months children to understand that phonetic units are used contrastively for assigning meaning to words. Kuhl et al. (1992), through a study focusing on speech prototypes, examined sixty-four infants and demonstrated that this shift takes place around 6 months of age. The 64 infants were divided in 32 American and 32 Swedish subjects, who discriminated the

English vowels /i/, prototypic in English and nonprototypic in Swedish, and the Swedish vowel /y/, prototypic in Swedish and nonprototypic in English. They found that the children infants showed a strong magnet effect for language-specific prototypes, a finding that, as claimed by the authors, would have implications on theories of both speech perception and language development.

Kuhl discusses these implications in 1993 article, in which she reviews her then latest studies and addresses the NLM theory in more detail. She remarks that the theory accounts for the early period of L1 speech perception development, prior to the stage in which children acquire word meaning and contrastive phonology, and affirms that the theory can also be related to L2 speech perception and acquisition. That is, Kuhl argues that the acquired L1 magnets alter the phonetic space, an alteration in which the native-language magnets pull L2 instances towards the L1 prototypes. As she states, “this will cause certain perceptual distinction to be minimized (those near the magnets themselves), while others are maximized (those far from the native-language magnet)” (p. 130). Drawing on this finding, Kuhl argues that the NLM theory can account for adults’ ability or difficulty in detecting L2 phonetic categories, a relevant issue in the other reviewed model of speech perception, the SLM. That is, according to Kuhl, the nearer the L2 sound is to the L1 magnet in the perceptual space, the more difficult its discrimination is.

Iverson & Kuhl (1995) deepen the discussion about the NLM model by reviewing some of their studies that corroborate the concept of magnet effect in adults’ speech perception. With reference to L2 speech perception and learning, they argue that, although L1 magnets limit the phonetic perceptual space, experiments with extensive L2 phonetic training have demonstrated that the L1 magnet boundaries can be modified (Logan, Lively & Pisoni, 1991; MacKain, Best & Strange, 1981, cited on p. 142; Flege, 1995). Another aspect of the NLM, which is particularly relevant to the present study, is that the theory holds that speech representation has a multimodal nature—both auditory and visual information help children to establish their native-language phonetic space. In other words, they argue that “the speech representational system is ‘polymodally mapped’ very early in life” (p. 147), as demonstrated by the classic study of McGurk and McDonald (1976) with both children and adults. The multimodal nature of speech perception has generated further analysis into the role of audio/visual integration in both L1 (e.g., Sekiyama & Tohkura; 1991; Massaro, Cohen & Smeele, 1996; Traunmüller & Öhström, 2004, 2007) and L2 (e.g., Hayashi & Sekiyama, 1998; Hazan et al. 2006), and has been one of the motivations of the present study.

Another aspect of the NLM, related to the SLM, is that it advocates that speech representations eventually guide speech production. Therefore, both models claim that accurate perception leads to and thus precedes accurate production of speech sounds.

Kuhl and colleagues (2008) offer an expanded version of the NLM based on the most recent studies concerning speech perception and language development. The expanded version of model—or NML-e— specifies four stages of language perception and language development. In phase 1, a period prior to 6 months of age, infants are language-universal perceivers, being able to discriminate any phonetic units in the world’s languages. In phase 2, a period after 6 months old, infants shift from language-universal to a language-specific mode of speech perception. Phase 3 is characterized by progress towards the acquisition of words, a period after the enhancement and settlement of the language-specific phonetic perception. Phase 4 is described as the stage in which the neural commitment related to L1 phonetic space is completely stable, so that any future language learning is probably affected by L1 knowledge. In this article Kuhl also made some predictions based on the rationale of the NLM-e, regarding phenomena such as the effects of bilingual linguistic experience, the durability and robustness of learning, and the mechanism underlying the critical period. Since these predictions are beyond the scope of the present study, they will not be discussed here.

To conclude, concerning the present study and in accordance with Kuhl's NLM theory, one could assume that by around 6 months old BP speakers would have created their prototypes for the nasals /m/ and /n/ in word-final position according to this language ambient input—through vowel nasalization and nasal deletion—and not fully realized as in English. Bearing in mind that the concept of speech prototypes is the main claim of the NLM, and that the idea of speech prototypes concerns the best instance of certain speech category, one should consider that in the case of BP, the best instance of a word-final /m/ and /n/ is one in which the phonological processes of vowel nasalization and nasal deletion occur. These prototypes would guide the BP listeners' perception, acting as perceptual magnets in the perception of word-final nasals, particularly in the initial stages of L2 learning, a process that might lead to misidentification.

Chapter 5

Method

The experiments described in this chapter were conducted to investigate the perception of the English nasals /m/ and /n/ in word-final position by a group of Brazilian intermediate learners of English and a group of native speakers of American English, as a reference for comparison. The choice of the intermediate level was based on the assumption that students of a lower level would probably make several kinds of mistakes in a more random manner, which could make it difficult to find a consistent trend. Intermediate students have been exposed to L2 for a longer period of time; therefore, they are more likely than beginners to have developed consistent strategies to perceive the English word-final nasals.

The data for the present study was collected in May and June, 2008 at the Universidade Federal de Santa Catarina (UFSC), in Florianópolis, Santa Catarina, with the Brazilian participants, and in August, 2008 in Pittsburgh, Pennsylvania with the American participants. For the purpose of data collection, five instruments were designed: three questionnaires and two perception tests. This chapter describes the research questions and hypotheses (as previously mentioned in the Introduction), the participants, the data collection instruments, the procedures, and the method employed for data and statistical analysis.

5.1 Research Questions and Hypotheses

In order to investigate perception of the word-final nasal by Brazilian EFL learners, the main research questions (RQ) and hypotheses (H) of this study were the following:

RQ 1: Are the Brazilian learners able to identify the native-like realization of English word-final nasals according to the presence or absence of a fully realized English word-final nasal?

H 1: The Brazilian learners will be better able to identify the native-like realization when it contrasts with the nonnative-like realization of English word-final nasals.
Background: Kluge (2004, 2007).

RQ 2: How does the height of the preceding vowel (high, medium and low) influence the Brazilian EFL learners' identification of English word-final nasals /m/ and /n/ in the Native-like versus Nonnative-like Identification Test?

H 2: Low preceding vowel will favor and high preceding vowel will disfavor the accurate identification of /m/ and /n/ in word-final position in the Native-like versus Nonnative-like Identification Test.
Background: Kluge (2004).

RQ 3: Which condition (Audio only, Audio/Video and Video only) favors the accurate identification of the word-final nasal /m/ and /n/?

H 3.1: The Audio/Video condition will favor/facilitate the accurate identification of both word-final nasals.
Background: Hazan, Sennema, Faulkner, Ortega-Llebaria, Iba & Chung (2006), Kluge (2007).

H 3.2: The Audio only condition will disfavor the accurate identification of both word-final nasals when compared to the Audio/Video condition.
Background: Kluge (2007).

RQ 4: How does the height of the preceding vowel (high, medium and low) influence the Brazilian EFL learners' identification of English word-final nasals /m/ and /n/ in each of the Three-condition Identification Tests?

H 4.1: High preceding vowel will disfavor the accurate identification of /m/ in word-final position in the Three-condition Identification Test.
Background: Sharf & Ostreicher, 1973; Kurowski & Blumstein, 1984; Repp, 1996; Zee, 1981, cited in Kurowski & Blumstein, 1995, p. 199; Kluge, 2004, 2007

H 4.2: Low preceding vowel will favor the accurate identification of /n/ in word-final position in the Three-condition Identification Test.
Background: Kluge (2007).

5.2 Participants

5.2.1 Brazilian Participants

Forty-two participants were tested: twenty-one women ranging from 18 to 27 (mean = 20.7 years) and twenty-one men ranging from 18 to 59 (mean = 24.2 years). All participants were considered intermediate students from UFSC, regularly attending either the seventh semester of English in the Extracurricular Language Program (39 out of 42), or the third semester of the undergraduate English program (3 out of 42).

The English course in the Extracurricular Language Program from UFSC consists of ten semesters divided as follows: (a) basic (levels 1 to 3); (b) pre-intermediate (levels 4 to 6); (c) intermediate (levels 7 and 8); and (d) advanced (levels 1 and 2). Each level has 60 hours of classes involving listening, speaking, reading and writing, emphasizing the first two skills. Therefore, the 39 participants of this study who were finishing level 7 had had around 420 hours of English classes.

The 3 participants of this study finishing the third semester of the undergraduate English program from UFSC had had around 396 hours of English classes also involving listening, speaking, reading and writing, divided as follows: (a) 108 hours of classes in the first semester; (b) 144 hours in the second semester; and (c) 144 hours in the third semester.

In order to guarantee a reasonably homogeneous group of participants, the researcher and the participants' teachers (all nonnative speakers of English) informally and holistically rated the pronunciation of the students, from observation of their participation in normal classes, on a 1-5 scale, 1 being totally nonnative-like and 5 being native-like see Appendix A). Students who were rated 1 or 5 were excluded in order to avoid having low or high proficient English speakers as participants. Only eight from a total of fifty students were thus excluded, leaving forty-two participants rated from 2 to 4.

Although the extracurricular classes are open to the community at large, all the participants were full-time undergraduate students from various majors at UFSC except participants 30 and 34, a lawyer and engineer, respectively. All participants reported residing in Florianópolis at the time of data collection.

Most of the Brazilian participants (34 out of 42) are from and have spent most of their lives in cities in the three southernmost states of Brazil (Santa Catarina, Rio Grande do Sul and Paraná). The other eight participants are from and have spent most of their lives in various states around the country.

Background information of the Brazilian participants is shown in Table 3, and Table 4 presents more detailed information about the English background of the Brazilian participants.

Table 3. Background information of the Brazilian participants.

Part No.	Gender	Age	Place of Bith	Most of life spent in:
1	F	21	Laguna-SC	Laguna-SC
2	F	19	São José-SC	São José-SC
3	F	20	Florianópolis-SC	Florianópolis-SC
4	F	19	Porto Alegre-RS	Florianópolis-SC
5	F	21	Florianópolis-SC	Florianópolis-SC
6	F	21	Florianópolis-SC	Florianópolis-SC
7	F	21	Florianópolis-SC	Florianópolis-SC
8	F	23	Joinville-SC	Florianópolis-SC
9	F	18	Iporã do Oeste-SC	Florianópolis-SC
10	F	22	Lages-SC	Lages-SC
11	F	18	Goiânia-GO	Goiânia-GO
12	F	27	Florianópolis-SC	Florianópolis-SC
13	F	21	Criciúma-SC	Criciúma-SC
14	F	19	Florianópolis-SC	Florianópolis-SC
15	F	20	Novo Hamburgo-RS	Novo Hamburgo-RS
16	F	20	Campo Grande-MS	Campo Grande-MS
17	F	19	Joinville-SC	Joinville-SC
18	F	25	Brasília-DF	Rio de Janeiro-RJ
19	F	18	São José do Cedro-SC	São José do Cedro-SC
20	F	23	Blumenau-SC	Blumenau-SC
21	F	20	Florianópolis-SC	Florianópolis-SC
22	M	23	Tenente Portela-RS	Florianópolis-SC
23	M	24	Tenente Portela-RS	Florianópolis-SC
24	M	20	Içara-SC	Içara-SC
25	M	26	Florianópolis-SC	Florianópolis-SC
26	M	20	Cruz Alta-RS	Cruz Alta-RS
27	M	20	Brasília_DF	Brasília-DF
28	M	20	Florianópolis-SC	Florianópolis-SC
29	M	21	Florianópolis-SC	Florianópolis-SC
30	M	59	Rio de Janeiro-RJ	Florianópolis-SC
31	M	20	São José-SC	São José-SC
32	M	20	Campina Grande-PB	Araraquera-SP
33	M	24	Florianópolis-SC	Florianópolis-SC
34	M	44	Torres-RS	Torres-RS
35	M	19	Jaraguá do Sul-SC	Jaraguá do Sul-SC
36	M	18	St. Terezinha de Itaipu-PR	St. Terezinha de Itaipu-PR
37	M	20	Belo Horizonte-MG	Blumenau-SC
38	M	21	Araçatuba-SP	Araçatuba-SP
39	M	20	Presidente Getúlio-SC	Presidente Getúlio-SC
40	M	23	Rio de Janeiro-RJ	Rio de Janeiro-RJ
41	M	21	Coronel Vivida-PR	Coronel Vivida-PR
42	M	25	Lages-SC	Lages-SC

Table 4. English background of the Brazilian participants.

Part	Pronunc. classes	Phonetic Symbols classes	Previous English study	Other Langs	Speak English out class.	Music/ Movies	Eng. accent
1	Yes	No	2 semesters	-	No	Yes	BE
2	Yes	Yes	2 classes	-	Yes	Yes	AE
3	No	No	-	Spanish	No	Yes	AE
4	No	No	-	Spanish	Yes	Yes	AE
5	Yes	Yes	1 semester	-	No	Yes	AE
6	No	No	-	-	No	Yes	AE
7	No	No	-	Spanish	No	Yes	AE
8	No	No	-	Italian	Yes	Yes	AE
9	No	No	-	German	No	Yes	AE
10	Yes	Yes	1 class	-	Yes	Yes	AE
11	Yes	Yes	2 classes	-	No	Yes	AE
12	No	No	-	Spanish	No	Yes	AE
13	Yes	Yes	Few classes	-	No	Yes	AE
14	No	No	-	-	No	Yes	AE
15	No	No	-	-	No	Yes	AE
16	No	No	-	-	Yes	Yes	BE
17	No	No	-	Spanish	No	Yes	AE
18	Yes	Yes	2 classes	Spanish	Yes	Yes	AE
19	No	No	-	-	No	Yes	AE
20	No	No	-	French	No	Yes	AE
21	Yes	Yes	1 semester	German	No	Yes	AE
22	Yes	Yes	1 class	Spanish	No	Yes	AE
23	Yes	Yes	2 classes	Spanish	No	Yes	AE
24	Yes	Yes	Few classes	-	No	Yes	AE
25	No	No	-	-	No	Yes	AE
26	No	No	-	Spanish	No	Yes	AE
27	Yes	Yes	1 class	Spanish	No	Yes	AE
28	Yes	Yes	1 class	-	No	Yes	AE
29	Yes	Yes	3 months	-	Yes	Yes	BE
30	No	No	-	Spanish	No	Yes	BE
31	Yes	No	2 semesters	-	No	Yes	AE
32	Yes	Yes	1 semester	French	No	Yes	AE
33	No	No	-	-	Yes	Yes	AE
34	Yes	Yes	1 class	Spanish	No	Yes	AE
35	No	No	-	-	No	Yes	AE
36	No	No	-	-	No	Yes	AE
37	No	No	-	-	No	Yes	AE
38	Yes	Yes	1 month	-	No	Yes	BE
39	No	No	-	German	Yes	Yes	AE
40	No	No	-	French	Yes	Yes	AE
41	No	Yes	1 month	Japanese	Yes	Yes	AE
42	No	No	-	-	No	Yes	AE

Note: AE: American English; BE: British English.

As shown in Table 4, eighteen of the forty-two participants reported that they had had some kind of formal instruction on English sounds and pronunciation, and seventeen of the participants reported they had had some kind of formal instruction on phonetic symbols. The table also shows that the time of formal instruction ranged from one single class to two semesters, as reported by the participants.

Table 4 also reveals that twenty-two participants reported having no knowledge of any language other than English. Twenty participants reported having some knowledge with other foreign languages, such as Spanish, German, French, Italian and Japanese. All participants also reported they listened to English songs, and watched English movies without dubbing. Most of the participants (37 out of 42) reported they considered they have an American English accent rather than a British one. None of them had been to any English speaking country.

All the participants also reported having neither hearing nor visual problems. The only material compensation given the participants for their participation was candy and five reais[1] (R$5.00), but they were promised – and given – feedback on their performance, which may have served as motivation to do their best.

5.2.2 American Participants

As a control group, ten native listeners of American English took the perception tests: five women ranging from 27 to 68 (mean = 45.6 years) and ten men ranging from 32 to 63 (mean = 44.2 years). All native listeners were living in Pittsburgh, Pennsylvania, at the time of data collection. An outline of the background information of each of the American participants can be seen in Table 5.

[1] Brazilian currency.

Table 5. Background information of the American participants.

Part	Gender	Age	Place of Bith	Place where spent most of life	Occup.	Edu.	Other Langs
1	F	68	Philadelphia-PA	Pittsburgh-PA	Professor	MA	-
2	F	27	Pittsburgh-PA	Pittsburgh-PA	Professor	PhD	-
3	F	43	Pittsburgh-PA	Pittsburgh-PA	Professor	MA	-
4	F	29	Waynesboro-PA	Pittsburgh-PA	Teacher	BA	-
5	F	61	Pittsburgh-PA	Pittsburgh-PA	Teacher	BA	French
6	M	63	Pittsburgh-PA	Pittsburgh-PA	Musician	BA	-
7	M	46	Pittsburgh-PA	Pittsburgh-PA	Lawyer	MA	French
8	M	38	Denver-CO	Pittsburgh-PA	Lawyer	MA	Spanish
9	M	32	Pittsburgh-PA	Pittsburgh-PA	Teacher	MA	-
10	M	42	Pittsburgh-PA	Pittsburgh-PA	Lawyer	MA	-

The table shows that most of the American participants (7 out of 10) are from and have spent most of their lives in Pittsburgh-PA. Most participants reported having no knowledge of any language other than English. The only exceptions are participants 5 and 7 who reported having knowledge of French, and participant 8 who reported having knowledge of Spanish. None of the ten American participants reported having any knowledge or contact with BP in their daily routines.

All the participants also reported they have neither hearing nor visual problems. On the day of data collection, each of the participants received ten dollars as a compensation for their participation.

5.3 Materials

In order to test participants' perception of the English nasals /m/ and /n/ in syllable-final position, three questionnaires and two tests were designed: (a) a Native-like versus Nonnative-like Identification Test (N-like vs. NN-like Identification Test), and (b) a Three-condition Identification Test. The questionnaires and the perception tests are described in the following subsections.

5.3.1 Questionnaires

Two questionnaires were designed in Portuguese for the Brazilian participants. One of them elicited the Brazilian participants' biographical information, such as age, gender and regional accent, as well as information related to their English learning experience (see Appendix B and C for Portuguese and English version, respectively). Among the questions asked were length and type of formal language study, experience in English-speaking countries, and amount and type of English input, such as listening to music, reading lyrics, watching movies and chatting on the internet.

The other Portuguese questionnaire was designed in order to evaluate the Three-condition Identification Test (a) by eliciting the Brazilian participants' impressions and opinions of each of the three conditions (Audio only, Audio/Video, Video only) concerning degree of difficulty and length of the test, and (b) by testing the degree of conformity of the three conditions to the participants' reality through questions concerning the attention normally paid to the movement of the mouth when they listen to either their L1 or the L2 (see Appendix D and E for Portuguese and English version, respectively).

A third questionnaire was designed in English in order to assess the biographical information of the American participants, such as age, gender and origin (see Appendix F).

5.3.2 Native-like versus Nonnative-like Identification Test

The first data-gathering instrument consisted of an identification test, based on Kluge (2004), to check to what degree the participants could identify N-like versus NN-like pronunciation of the English word-final nasal consonants /m/ and /n/, distinguished by the presence or absence of the nasal consonants and the nasalized or oral pronunciation of the preceding vowels.

As stated above, this identification test was based on Kluge (2004, 2007), who adapted some characteristics of the CDT (Flege, Munro & Fox, 1994), such as *same* and *different* trials, and different talkers within the trial. Therefore, the audio-stimuli were recorded, in two individual sessions, by two women: an American native talker of English, who was also proficient in BP, and a native talker of BP, also proficient in English. The recordings were made so that the vowels in the NN-like realization maintained the English vowel quality even when nasalized; e.g., the /ɪ/ in *Tim* and *tin* were produced as a nasalized version of [ɪ], not of [i] as a typical Brazilian pronunciation. As these nonnative pronunciations were not native for either of the talkers, they had phonetic training in order to control their pronunciation so that the presence/absence of the nasal consonant and the nasal/oral quality of the vowel would be the only differences in the pronunciation of the target words. Each word was recorded by each speaker twice with a N-like pronunciation and twice with an intentional Brazilian pronunciation. The best production of each word was selected by the researcher and an assistant with phonetic training. The words were recorded in the program Sound Forge 7.0 and normalized for peak intensity.

The test contained forty-eight trials, each consisting of two pronunciations of each monosyllabic CVC word. The target words were three minimal pairs contrasting /m/ and /n/ in word-final position and proceeded by a high (/ɪ/), mid (/ɛ/), or low (/æ/) vowel: *Tim/tin*[2], *gem/gen* and *cam/can*. Each member of the three minimal pairs was repeated eight times. Of the total of forty-eight trials, twenty-four were *different* trials and twenty-four were *same* trials. The *different* trials contained the two different pronunciations of the same word: N-like and NN-like (e.g., /tɪm/- /tɪ̆/). The *same* trials contained no contrast; that is, both pronunciations of the target monosyllabic word were the same, either two N-like pronunciations or two NN-like pronunciations (e.g., either /tɪm/-/tɪm/ or /tɪ̆/ /tɪ̆/). In each trial one item was spoken by the native talker of English and the other by the native talker of BP. Each trial appeared twice, the second time with the talkers reversed. Thus, each of the six words appeared in four different trials and four different same trials (see Appendix G).

The Praat 5.0 software was used to sequence and digitally edit the words and to set the inter-stimulus interval at 1.3 s, following Flege (1994) and Koerich (2002). The order of the trials was randomized for each participant to minimize any ordering effect. Then the words were inserted into the Presentation software developed at the Institute of Phonetic Science at the University of Amsterdam especially for this research, for individual presentation to the participants. The program provided the participants with the written word on the screen because a small-scale pilot study (Kluge, 2004) showed that lack of this information could compromise the results, even with highly proficient speakers of English. On the screen, for each trial, there were buttons for the participants to click to indicate which pronunciation(s) of each word sounded more American

[2] The pronunciation of /t/ was not palatalized, as it is typically done by Brazilian learners of English (Bettoni-Techio, 2007).

native-like: *1, 2; both* if they considered both pronunciations native-like; or *neither* if they considered neither pronunciation native-like. An example is reproduced in Figure 4

Figure 4. Example of the N-like vs. NN-like Test.

After each trial was played, only once, the answer's buttons turned from grey to black, so that the participants could click on their answer. After that, the software automatically generated the next screen with a new word and, 3 seconds later, a new trial was played. Thus, the participants could not begin the following trial before answering the previous one.

A familiarization task of six trials was also designed (see Appendix H), consisting of three *different* trials and three *same* trials, but with other difficult pronunciation items instead of the nasals, as shown in Figure 5. The order of the trials of the familiarization task was also randomized for each participant in order to minimize any ordering effect.

Figure 5. Example of the familiarization task of the N-like vs. NN- like Test.

5.3.3 Three-condition Identification Test

The second data gathering instrument consisted of an identification test format with and without visual cues to assess L2 learners' perception of word-final nasal consonants and the importance of visual cues for this perception. The test followed the design of the Three-condition Identification Test described by Hazan et al. (2006) to assess second-language learners' sensitivity to phonetic information contained in visual cues when they have to identify a non-native phonemic contrast. The words were the same as those of the first identification test (*Tim/tin*, *gem/gen* and *cam/can*), but this time with only native pronunciation.

The six monosyllabic words with /m/ or /n/ in the word-final position were presented in three conditions: (a) Audio only (*A only*), in which the participants heard one pronunciation of each word; (b) Audio/Video (*AV*), in which the participants heard and saw one pronunciation of each word; and (c) Video only (*V only*), in which the participants only saw one pronunciation of each word.

For the construction of the test, a phonetically trained male speaker of American English recorded each of the test items. Video recordings were made in a soundproof room on a Canon Elura 40-MC digital camcorder. The talker's mouth was fully visible in the frame during the recording of each item. The camera was set to record in stereo at 44.1 kHz, 16 bits. The video was recorded at full digital video resolution, 720 x 480 pixels. After recording, the video with sound was imported into an Apple Macintosh PowerBook G4 using Apple's consumer video editing program iMovie. In iMovie, the video stream was edited to isolate and separate the individual items into separate video clips, after which the iMovie project was saved and duplicated twice, resulting in a total of three copies. The video clips were edited so that the start and end of the pronunciation of each word showed a neutral face expression.

The test items were the same in each of the three conditions, but in the *A only* and *V only* conditions, either the auditory or visual cues were removed. For the *A only*, one copy of the project was opened, and the audio was extracted from the video and exported into a separate file at its original 16 bit, 44.1 kHz stereo resolution. The *A only* file of all words was edited into separate files with Bias software's Peak DV program, and ultimately all words were saved into their own AIFF file. These files were later converted to MP3 with Apple's iTunes software. For the *V only*, the second copy of the project was opened in iMovie, the audio was removed, and the words were exported individually as 320 x 240 pixel AVI files. For the *AV*, the third copy of the project was opened in iMovie, and the video clip of each word was exported as a 320 x 240 pixel AVI file, with audio at full 16 bit, 44.1 kHz stereo resolution.

In order to verify if the stimuli recorded were good exemplars of the target phonemes, the realization of each of the six words from each of the three conditions pronounced by the American talker was duplicated, randomized and played to an American speaker of English who correctly identified all the test items. Thus, none of the test items had to be eliminated or recorded again.

The test taken by the participants consisted of 48 items per condition; that is, each of the six words was repeated eight times. Thus, there were 48 tokens for each of the three conditions (a total of 144 tokens), 24 tokens for each of the target word-final nasals in each of the three conditions.

This test was also conducted with the Presentation software and the order of the items of each condition was randomized for each participant in order to minimize any ordering effect. The software was also programmed not to play any of the target words twice in sequence.

Hazan and colleagues (2006) suggested two orders for the presentation of the three conditions: *A only, AV, V only* or *AV, A only, V only*. According to the authors, the *V only* condition was always presented last because it is likely to be the most difficult condition for the participants. However, a pilot test (Kluge, 2007) showed that the *V only* condition was not the most difficult one for the identification of the English word-final nasals /m/ and /n/. Therefore, for the purpose of this study, there were six orders of presentation of the three conditions: (a) *A only, AV, V only*; (b) *A only, V only, AV*; (c) *AV, V only, A only*; (d) *AV, A only, V only*; (e) *V only, A only, AV*; and (f) *V only, AV, A only*. The six orders were counterbalanced; that is, seven participants performed this perception test in each one of the six different orders of presentation.

The task of the participants in each trial of each condition was to click on the button corresponding to the English word-final nasal (/m/ or /n/) they heard and/or saw. See Figures 6 and 7 for examples.

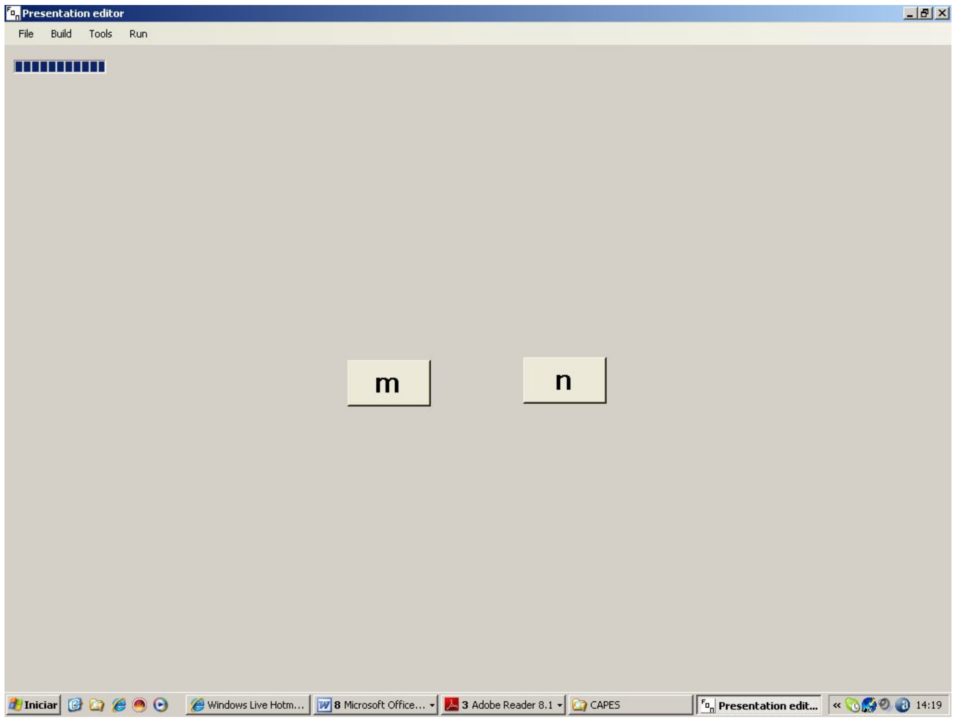

Figure 6. Example of *A only* condition.

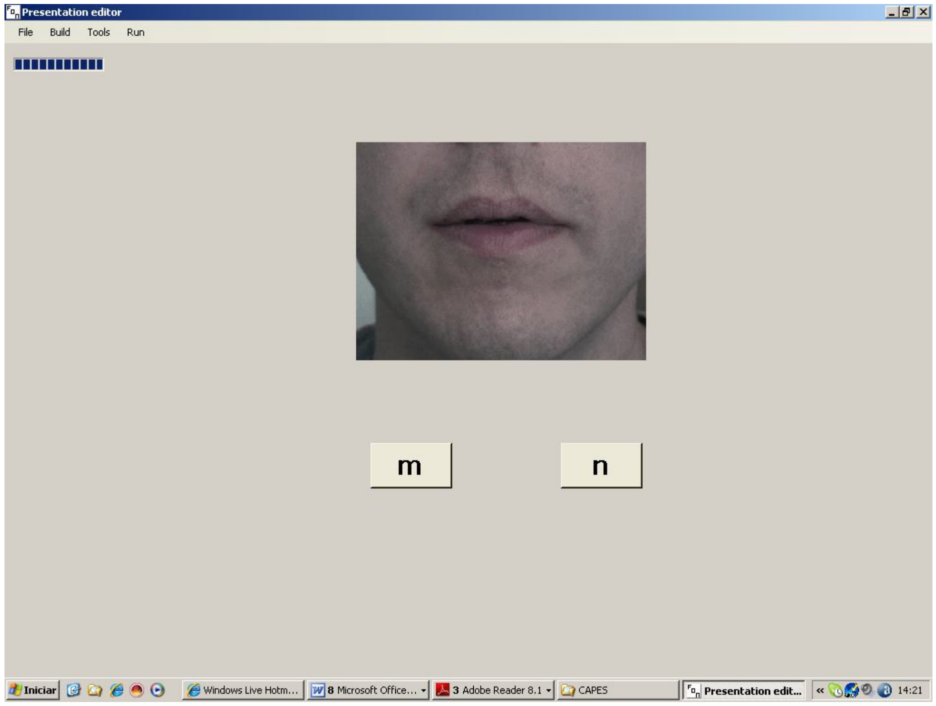

Figure 7. Example of *AV* and *V only* conditions.

After each trial was played and/or shown, just once, the answer buttons turned from grey to black, for the participants to click on their answer. After that the software automatically generated the next screen with a new set of buttons, and, 3 seconds later, a new stimulus was played. Therefore, participants could not hear and/or see the stimulus again before giving an answer.

A familiarization task was also designed, with eight items from other minimal pairs contrasting different word-final sounds for each of the three conditions. The minimal pairs were: *bed/bet* and *bid/bit*. See Figure 8 and Figure 9 for examples. The order of the trials of the familiarization task was also randomized for each participant to minimize any ordering effect.

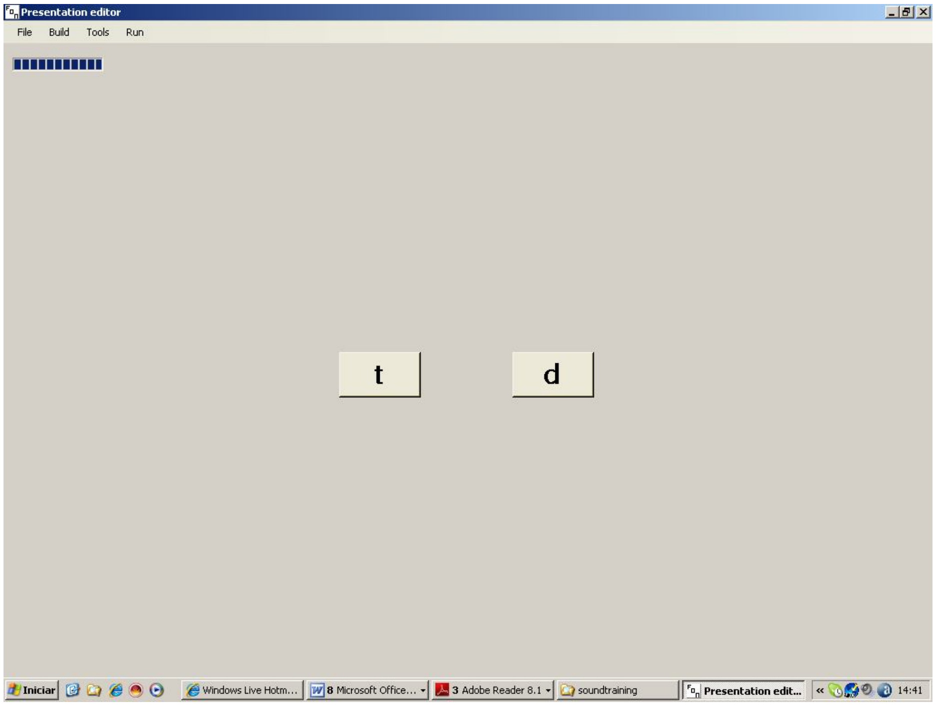

Figure 8. Example of the familiarization task of *A only* condition.

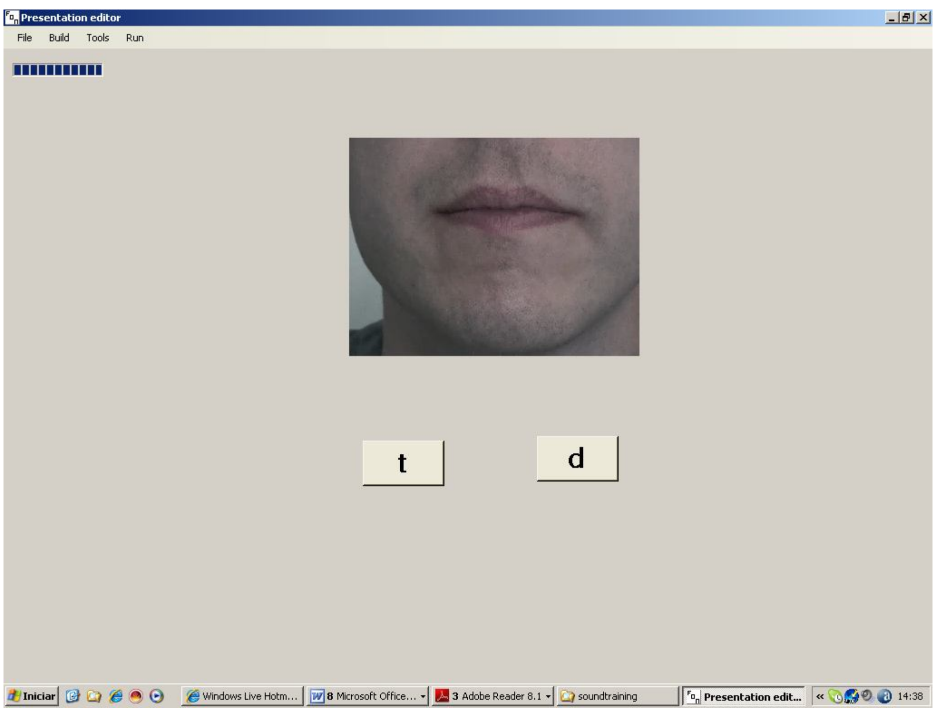

Figure 9. Example of the familiarization task of the *AV* and *V only* conditions.

5.4 Procedures

This section reports the procedures for data collection with the Brazilian and the American participants.

5.4.1 Procedures with the Brazilian participants

The participants knew they were participating in a research project, but none of them was aware of the exact purpose of the study. Data was collected individually, by the researcher, in a quiet room at UFSC on a laptop computer. To perform the perception tests appropriately, the participants used Sony headsets. The oral instructions before all tests were given in BP. First, the participants answered the questionnaire with their biographical information. The other questionnaire was answered by the participants immediately after each of the conditions in the Three-condition Identification Test with/without visual cues. The data collection took approximately 40 minutes, and as explained in 5.4.3, there were six orders for presentation of the Three-condition Identification Test and seven participants in each order, as follows: (a) *A only, AV, V only* (participants 1, 8, 13, 19, 25, 31 and 37); (b) *A only, V only, AV* (participants 2, 9, 14, 20, 26, 32 and 38); (c) *AV, V only, A only* (participants 3, 10, 15, 21, 27, 33 and 39) ; (d) *AV, A only, V only* (4, 11, 16, 22, 28, 34 and 40); (e) *V only, A only, AV* (participants 5, 7, 17, 23, 29, 35 and 41); and (f) *V only, AV, A only* (participants 6, 12, 18, 24, 30, 36 and 42).

The general order followed by all Brazilians was: (a) Familiarization task of the N-like vs. NN-like Identification Test, (b) N-like vs. NN-like Identification Test, (c) Familiarization of the first of the Three-condition Identification Test, (d) The first condition of the Three-condition Identification Test, (e) Questionnaire about the first test condition, (f) Familiarization of the second of the Three-condition Identification Test, (g) The second condition of the Three-condition Identification Test, (h) Questionnaire about the second test condition, (i) Familiarization of the third of the Three-condition Identification Test, (j) The third condition of the Three-condition Identification Test, and (k) Questionnaire about the third test condition. While the researcher was organizing the following step, the participants had a short break of 1-2 minutes.

5.4.2 Procedures with the American participants

The participants of the control group knew they were participating in a research project, but none of them was aware of the exact purpose of the study. Data was collected individually on a laptop computer by a trained researcher who was living in Pennsylvania at the time. To perform the perception tests appropriately, the participants used Sony headsets. First, the participants answered the questionnaire with their biographical information. The data collection took approximately 25 minutes. As the control group had 10 participants and, as previously explained, there were six orders for presentation, there was not an even number for each order of presentation of the Three-condition Identification Test. Therefore, the participants were divided as follows: (a) *A only, AV, V only* (participants 1 and 7); (b) *A only, V only, AV* (participants 2 and 8); (c) *AV, V only, A only* (participants 3 and 9); (d) *AV, A only, V only* (participants 4 and 10); (e) *V only, A only, AV* (participant 5); and (f) *V only, AV, A only* (participant 6).

The general order followed by all the Americans was: (a) Familiarization task of the N-like vs. NN-like Identification Test, (b) N-like vs. NN-like Identification Test, (c)

Familiarization of the first of the Three-condition Identification Test, (d) The first condition of the Three-condition Identification Test, (e) Familiarization of the second of the Three-condition Identification Test, (f) The second condition of the Three-condition Identification Test, (g) Familiarization of the third of the Three-condition Identification Test, and (h) The third condition of the Three-condition Identification Test, While the researcher was organizing the following step, the participants had a short break of 1-2 minutes.

5.5 Analysis

In order to investigate the Brazilian participants' perception of the English word-final nasals, the statistical analysis was based on the total of 2016 responses (48 for each of the forty-two participants) for the N-like vs.. NN-like Identification Test, considering the *different* trials and the *same* trials, and 6048 responses (48 for each of the forty-two participants for each of the three conditions) for the Three-condition Identification Test (2016 responses for each condition).

For comparison, the statistical analysis of the control group was based on the total of 480 responses (48 for each of the ten participants) for the N-like vs.. NN-like Identification Test, considering the *different* trials and the *same* trials, and 1440 responses (48 for each of the ten participants for each of the three conditions) for the Three-condition Identification Test (480 responses for each condition).

Statistical tests were run using the software SPSS for Windows – version 14.0, and the level of statistical significance (alpha level) was set at .05.

Skewness and kurtosis were verified for normal distribution and as the results where not normally distributed two nonparametric tests were used: (a) Friedman for within-group comparison of means, and (b) Wilcoxon, as a *post hoc* test that verifies the relation between the variables that reached significance in the Friedman test.

As the results of skewness and kurtosis were also inconsistent between the two groups, all results were considered not normally distributed for the between-group comparison. Therefore, statistical analysis was verified through a Mann-Whitney U test.

Chapter 6

Results and Discussion

This chapter reports and discusses the results of the performance of the American listeners and the Brazilian listeners on the Native-like versus Nonnative-like Identification Test (N-like vs. NN-like Identification Test) and on the Three-condition Identification Test. It is divided into two major sections – (6.1) perception of the native listeners, and (6.2) perception of the Brazilian listeners - which shows overall results in each of the perception tests, and reports and discusses the results concerning the research questions and hypotheses presented in the previous section (6.1). A comparison between the performances of both groups will be also provided throughout this chapter. The last major section (6.3) summarizes and further discusses the results.

6.1 Perception of the American listeners

6.1.1 N-like versus NN-like Identification Test

6.1.1.1 Overall results of N-like versus NN-like Identification Test

The individual results of the identification of N-like versus NN-like realization of English word-final nasals /m/ and /n/ by the American listeners (the control group) are displayed in Table 6. The table indicates the number of correct identifications for each of the target nasals by each of the ten participants, including both the *different* and *same* trials. As stated in Chapter 5, there are 5 men and 5 women in the American group. Investigating gender is not the focus of this research, but the Wilcoxon statistical test was applied in order to discard its importance as a variable. The test revealed that the performance of men and women was not statistically different for either /m/ (Z = - 1.40, p = .136) or /n/ (Z = - .365, p = .715).

Table 6. Individual results of the N-like vs. NN-like Identification Test by the American listeners.

	/m/		/n/		/m/ - /n/	
	No. Correct Answers n = 24	% Correct Answers	No. Correct Answers n = 24	% Correct Answers	No. Correct Answers n = 48	% Correct Answers
1	15	62.5	19	79.2	34	70.8
2	20	83.3	11	46.8	31	64.6
3	17	70.8	10	41.7	27	56.2
4	13	54.2	9	37.5	22	46.8
5	20	83.3	11	46.8	31	64.6
6	9	37.5	10	41.7	19	39.6
7	19	79.2	19	79.2	38	79.2
8	11	46.8	10	41.7	21	43.7
9	15	62.5	12	50.0	27	56.2
10	11	46.8	6	26.0	17	36.5
Total	150	62.5	117	48.7	267	56.6
		N = 240		N = 240	N = 480	

The overall results, considering both nasal consonants, reveal that the identification of the N-like realization of word-final nasal consonants in contrast to the NN-like one was difficult for the American listeners, as they identified the N-like realization in only 56.6% of the trials. Moreover, the overall results show considerable variability among the individual scores of the participants, ranging from 36.5% (minimum score) to 79.2% (maximum score). Six out of ten participants identified less than 57% of the trials correctly, and the other 4 participants scored within the 64-80% range.

As for the identification of each target nasal consonant separately, Table 6 shows that N-like /m/ was accurately identified by the American listeners in 62.5% of the trials, whereas N-like /n/ was accurately identified only in 48.7% of the trials. A Wilcoxon test showed that this difference was statistically significant (Z = -1.960, p = .05), indicating a nasal consonant effect. Thus, the identification of the N-like bilabial nasals in word-final position was less difficult for the American listeners than the identification of the N-like alveolar.

As can be seen, overall results show that this test was particularly difficult for the American listeners, whose performance in the present study was unexpectedly lower compared to the results of Kluge (2004). However, it should be borne in mind that the control group of the present study consisted of 10 participants without experience with BP, whereas Kluge's 2004 study worked with three American speakers with experience with BP, as explained in section 3.2. In order to investigate why the test was difficult for the American listeners of this study, additional variables will be investigated, such as type of trial – discussed in 6.1.1.2 – and whether there was an effect of the native language of the talker (American English and BP) – discussed in 6.1.1.3. Since these results were unexpected, no hypotheses were previously elaborated concerning these variables.

6.1.1.2 Results of N-like vs. NN-like Identification Test by type of trial

As explained in the previous chapter, two types of trial were designed for this identification test: *different* trials in which the N-like pronunciation appeared in one of the two positions *1* or *2*, and *same* trials in which there was no different pronunciation and the correct answer would be either *both* (were N-like) or *neither* (was N-like). Table

7 shows the overall results of the native listeners regarding type of trial (*same* and *different*) for each of the target nasal consonants in word-final position.

Table 7. American listeners' group results by type of trial in the N-like vs. NN-like Identification Test.

	Different trials		*Same* trials	
Nasal consonant	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers
/m/	84	70.0	66	56.0
/n/	68	56.7	49	40.8

Note: n = 120 for each type of trial for each consonant

Table 7 shows that the N-like English word-final nasal /m/ was less frequently identified in the *same* trials (55%) than in the *different* ones (70%). However, a Wilcoxon test was run and revealed the difference was not significant (Z = -1.492, p = .136). Results indicate that there was not a type of trial effect in the accurate identification of the N-like realization of /m/ by the American listeners.

As for /n/, the table reveals that the N-like realization of this nasal was also less frequently identified in the *same* trials (40.8%) than in the *different* ones (56.7%). The Wilcoxon test showed that this is a significant difference (Z = -2.324, p = .020). Thus, the results indicate that there was an effect for *same* trials to disfavor the accurate identification of the N-like pronunciation of /n/ by the American listeners, but not for /m/, although the tendency was in the same direction for both.

In order to further investigate why the American listeners had such difficulty in correctly identifying the N-like realization of /m/ and /n/ in contrast to the Brazilian NN-like realization, Tables 8 and 9 show the actual responses of the American listeners for each of the four possible answers (*1*, *2*, *both* or *neither*) in the identification of N-like /m/ and /n/, respectively. The tables will be presented separately.

The test had 48 trials for each participant, 24 for /m/ and 24 for /n/. For each nasal consonant, the four possible answers (*1, 2, both*, *neither*) were presented 6 times each. As there were 10 listeners, there were 60 responses for each of the four possible answers for each consonant. In both Tables 8 and 9, the correct responses and percentages for each of the four possible answers are in bold.

Table 8. American listeners' responses in the identifications of N-like *vs.* NN-like /m/.

Possible answers	Participants' responses for /m/							
	1		*2*		*Both*		*Neither*	
1	**46**	**(76.7)**	3	(6.0)	7	(11.7)	4	(6.7)
2	11	(18.3)	**38**	**(63.3)**	9	(16.0)	2	(3.3)
Both	13	(21.7)	7	(11.7)	**39**	**(66.0)**	1	(1.7)
Neither	18	(30.0)	14	(23.3)	1	(1.7)	**27**	**(46.0)**

Note: n = 60 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

As regards the identification of N-like /m/, Table 8 shows that the percentages of correct answers for possible answers increased from *neither* (46%) to *2* (63.3%) to *both* (66%) to 1 (76.7%). The Friedman statistical test showed a significant effect for type of answer in the identification of N-like pronunciation of word-final /m/ (X^2 (3, N = 10) = 10.081, p = .018). Therefore, Wilcoxon *post hoc* tests were run in order to verify which pairs of possible answers were significant. The results show that for three pairs the difference was not significant: *1* versus *2* (Z = -1.131, p = .258), *1* versus *both* (Z = -.922, p = .357), and *2* versus *both* (Z = -.175, p = .861). However, the differences for *neither* versus *1* and *neither* versus *2* were significant: (Z = -2.555, p = .011) and (Z

= -2.209, *p* = .027) respectively. As for the pair *both* versus *neither*, the Wilcoxon yielded a nearly significant result (Z = -1.919, *p* = .055).

Thus, the results indicate that it was difficult for the American listeners to perceive when both realizations of the word-final nasal /m/ were NN-like, that is, when the answer was *neither*. Furthermore, when the American listeners heard two NN-like pronunciations (*neither*), they either responded correctly (45%) or responded *1* (30%) or *2* (23.3%); they responded *both* when it was *neither* only once (1.7%).

Although statistical tests showed a non-significant difference for *both* versus all other possible answers, Table 8 also shows that when the American listeners heard two N-like realizations of /m/, they either responded correctly (65%) or responded *1* (21.7%) or *2* (11.7%); they responded *neither* when it was *both* only once (1.7%). Thus, in almost all the *same* trials, the American listeners responded either correctly or *1* or *2*; they almost never responded *neither* when it was *both* or *both* when it was *neither*. This may indicate that when the American listeners noted a slight difference in one of the two realizations within the trial, they tended to choose one as more N-like than the other, especially when both realizations were NN-like.

In relation to the analysis of identification of word-final /n/, Table 9 shows the participants' responses and percentages for each of the four possible answers. The correct responses are in bold.

Table 9. American listeners' responses in the identifications of N-like vs. NN-like /n/.

Possible answers	Participants' responses for /n/							
	1		*2*		*Both*		*Neither*	
1	**35**	**(58.3)**	5	(8.3)	13	(21.7)	7	(11.7)
2	8	(13.3)	**33**	**(56.0)**	13	(21.7)	6	(10.0)
Both	14	(23.3)	17	(28.3)	**29**	**(48.3)**	0	(0.0)
Neither	20	(33.3)	15	(26.0)	5	(8.3)	**20**	**(33.3)**

Note: n = 60 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

Table 9 shows that, somewhat differently from the order for /m/, the total percentages of correct response for /n/ increased from *neither* (33.3%) to *both* (48.3%) to *2* (56%) to *1* (58.3%). Friedman showed a non-significant effect for type of possible answer in the identification of N-like pronunciation of word-final /n/ (X^2 (3, N = 10) = 6.314, p = .097). However, as previously mentioned, the Wilcoxon statistical test revealed that there was a significant difference for the results of *same* (*both* and *neither*) versus *different* trials (*1* and *2*). Thus, results indicate that it was more difficult for the American listeners to perceive that the two realizations of the word-final nasal /n/ were either N-like or NN-like than to perceive that there was a contrast.

Table 9 also shows that when the American listeners heard either two N-like or two NN-like pronunciations, they either responded correctly (48.3% for *both*, and 33.3% for *neither*) or responded 1 (23.3% for *both*, and 33.3% for *neither*) or *2* (28.3% for *both*, and 25% for *neither*); they never responded *neither* when it was *both*, and there were only 5 responses for *both* when it was *neither*. Thus, the results for /n/, as well as for /m/, may indicate that when the American listeners noted a slight difference in one of the two realizations within the trial, they tended to choose one as more N-like than the other, especially when both realizations were NN-like.

As mentioned above, in order to further investigate possible variables that could have influenced these results, the participants' responses will be analyzed in terms of: (a) talker, as the stimuli were either spoken by a native English speaker (the American talker) or a nonnative English speaker (the Brazilian talker), and (b) type of realization, as the stimuli as either N-like or NN-like realizations of English word-final nasals.

6.1.1.3 Results of N-like vs. NN-like Identification Test by talker and type of realization

6.1.1.3.1 Identification of N-like /m/ and /n/ in *different* trials

Tables 10 and 11 show the responses of the American listeners for /m/ and /n/, respectively, in the *different* trials, according to talker and type of realization. For this purpose, the participants' responses were grouped as N-like realization and NN-like realization disregarding the trial position, either *1* or *2*, and *both* and *neither.* As the participants were instructed to choose the most American N-like pronunciation, the correct response would be the N-like realization produced by either the N talker or the NN talker. Therefore, in Tables 10 and 11, there are four possible participants' response types: correct N-like realization (*correct N-like realization*), incorrect NN-like realization (*incorrect NN-like realization*), *both* or *neither*, which were also incorrect. The number of participants' responses in each table was based on 60 trials for each of the 4 possible answers.

Table 10. American listeners' responses for /m/ in the *different* trials according to talker and type of realization.

Participants' Responses	N-like realization by N talker /m/		N-like realization by NN talker /m/	
Correct N-like realization	**57**	**(95.0)**	**27**	**(45.0)**
Incorrect NN-like realization	1	(1.7)	13	(21.7)
Incorrect Both	2	(3.3)	14	(23.3)
Incorrect Neither	0	(0.0)	6	(10.0)
Total	60	(100.0)	60	(100.0)

Note: n = 60 for each possible answer. Percentages are in parentheses.

Table 10 shows that the American listeners correctly identified the N-like realization of /m/ by the N talker in 95% of the trials, whereas they correctly identified the N-like one by the NN talker in only 45% of the trials. The Wilcoxon statistical test was run and revealed that this difference is significant (Z = -2.527, p = .012). Thus, results indicate that there seems to be a talker effect for the American listeners, who identified the N-like realization by the N talker more easily than when produced by the NN talker.

The table also shows that when the participants did not accurately identify the N-like production by the N talker there was only one response for the NN-like realization (1.7%); two responses for *both* (3.3%), and not a single response for *neither*. A Friedman test was run and yielded significant differences (X^2 (3, N = 10) = 26.478, p = .000), and a Wilcoxon *post hoc* test confirmed that the differences were significant between the results of N-like realization by the N talker and all three other possible responses: (Z = -2.913, p = .004), (Z = -2.913, p = .004), and (Z = -2.919, p = .004) respectively. Hence, the results confirm that when the N-like realization was produced by the N talker, the American listeners were significantly more likely to correctly identify it as such than to choose any of the three incorrect responses.

Moreover, when the American listeners did not accurately identify the N-like production by the NN talker, they chose the NN-like one by the N talker in 21.7% of the trials, *both* in 23.3% of the trials, and *neither* in 10% of the trials. The Friedman test revealed the differences are not significant (X^2 (3, N = 10) = 6.375, p = .146). The lack of significant difference indicates that, contrary to the results for the N-like productions by the N talker, the N-like productions by the NN talker were no more likely to be identified as N-like than as NN-like or the same as the NN production. This may indicate that the American listeners perceived the pronunciation in a more holistic manner, thus relying on additional perceptual cues, and not only on the absence or presence of the full realization of the word-final nasal consonants to decide which of the two realizations they heard was more N-like.

Concerning the identification of the native-like /n/, Table 11 shows the American listeners' responses in *different* trials according to talker and realization.

Table 11. American listeners' responses for /n/ in the *different* trials according to talker and type of realization.

Participants' Responses	N-like realization by N talker /n/		N-like realization by NN talker /n/	
Correct N-like realization	**48**	**(80.0)**	**20**	**(33.3)**
Incorrect NN-like realization	6	(10.0)	7	(11.7)
Incorrect Both	5	(8.3)	21	(35.0)
Incorrect Neither	1	(1.7)	12	(20.0)
Total	60	(100.0)	60	(100.0)

Note: n = 60 for each possible answer. Percentages are in parentheses.

Table 11 shows that the American listeners correctly identified the N-like realization by the N talker in 80% of the trials, whereas they correctly identified the N-like realization by the NN talker in only 33.3% of the trials. The Wilcoxon was run and yielded a significant difference (Z = -2.677, p = .007). Thus, the results indicate that there seems to be a talker effect for the Americans listeners, who identified the N-like realization of the word-final /n/ produced by the N talker more easily than the N-like realization produced by the NN talker. These results are consistent with those found for the bilabial nasal consonant.

The table also shows that when the American listeners did not correctly identify the N-like realization of /n/ by the N talker, they marked the NN-like realization six times (10%), *both* five times (8.3%), and *neither* only once (1.67%). A Friedman test yielded significant differences (X^2 (3, N = 10) = 20.259, p = .000); thus, the Wilcoxon *post hoc* test was run and confirmed a significant difference between the results of N-like realization by the N talker and all three other possible responses – (a) for the *correct N-like realization* by the N talker versus *incorrect NN-like realization* by the NN talker (Z = -2.717, p = .007), (b) versus *incorrect both* (Z = -2.816, p = .005), and (c) versus *incorrect neither* (Z = -2.825, p = .005). Thus, just as for the bilabial nasals, the results confirm that the identification of the N-like realization of the alveolar nasals by the American listeners was significantly favored when pronounced by the N talker.

As for the responses for the N-like realization of /n/ by the NN talker in different trials, Table 11 reveals that when the American listeners did not correctly identify the N-like realization by the N talker, they chose the NN-like realization by the N talker in 11.7% of the trials, *neither* in 20% of the trials, and *both* in 35% of the trials. In fact, percentages of responses for *both* were higher than for the accurate response *correct N-like realization* by the NN talker - 35% and 33.3% respectively. The Friedman test revealed that, just as for the bilabial consonants, the differences for the alveolar consonants produced by the NN talker are not significant (X^2 (3, N = 10) = 6.826, p = .120). The lack of significant difference suggests that the productions by the NN talker were no more likely to be identified as N-like than as NN-like or the same as the nonnative production.

6.1.1.3.2 Identification of /m/ and /n/ in *same* trials

Table 12 and 13 show the responses of the American listeners for the *same* trials, when the correct answers were either *both* or *neither* for the identification of /m/ and /n/, respectively, regarding type of realization. For the *both* trials, there were four possible answers: the correct response *both*, and three other incorrect responses (*1, 2* and *neither*). For the *neither* trials, there were four possible answers: the correct response *neither* and three other incorrect responses (*1, 2* and *both*). If the correct answer was *both*, for example, consequently any other answer was computed as incorrect. However, for examining whether there was a talker effect within the incorrect responses (which could be either *1, 2* or *neither*), the researcher analyzed the listeners' responses when they chose *1* and *2* only, a response that would show that they may have judged one of the talkers' production as more N-like even when both were supposed to be perceived as N-like. The reasoning is that if the listeners cannot perceive that both realizations are N-like and kept repeating a pattern in choosing one of the talkers, then the stimuli produced by this particular talker was biasing the listeners' perception, that is, there was a talker effect on the choice of the responses. The same reasoning was done for the *neither* trials.

Tables 12 and 13 show the participants' responses for the identification of /m/and /n/ respectively, when the correct response was either *both* or *neither*. For both the incorrect participants' responses were named *N talker's realization* and *NN talker's* *realization,* and *neither*, whereas for neither the incorrect participants' responses were named *N talker's realization* and *NN talker's realization,* and *both.*

Table 12. American listeners' responses for/m/ in the *same* trials

Participants' Responses	Both realization N-like		Neither realization N-like	
	/m/		/m/	
N talker's realization	17	(28.3)	31	(51.7)
NN talker's realization	3	(6.0)	1	(1.7)
Both	**39**	**(66.0)**	1	(1.67)
Neither	1	(1.7)	**27**	**(46.0)**
Total	60	(100.0)	60	(100.0)

Note: n = 60 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

Table 12 shows that in most of the trials in which they did not accurately answer *both*, they chose the N talker's realization (17 times – 28.3%). They chose the NN talker's realization only three times (5%) and *neither* only once (1.7%). A Friedman test yielded significant differences (X^2 (3, N =10) = 17.313, p = .001) among the four responses. However, whereas the Wilcoxon *post hoc* test confirmed significance between the results of *both* versus *neither* (Z = -2.814, p = .005), and *both* versus *NN talker's realization* (Z = -2.662, p = .008), it confirmed a non-significant difference between the results of *both* and *N talker's realization* (Z = -1.640, p = .101), meaning that one answer was just as likely as the other. In other words, when the American listeners did not accurately answer *both*, they chose the realization produced by the N talker as N-like, but their choice (or not) of the realization produced by the NN talker was apparently random, as Wilcoxon yielded significance between the results of *N talker's realization* and *NN talker's realization* (Z = -2.226, p = .026). As discussed in (6.1.1.3.1) above, this may indicate that the American listeners based their responses on holistic N-like or NN-like characteristics of the realizations, rather than just on the realization or lack of realization of the final nasal consonant.

As regards the American listeners responses for the *neither* trials in the identification of N-like word-final /m/, Table 12 also shows that percentages of responses for *N talker's realization* were higher than for the correct response *neither*, 51.7% and 45%, respectively, again suggesting that the listeners tended to identify the N talkers´ realizations as being N-like, regardless of the realization or not of the final nasal. There was also only one response for *NN talker's realization* and one for *both*. A Friedman test showed significant differences (X^2 (3, N = 10) = 23.621, p = .000), and the Wilcoxon *post hoc* test confirmed significance between the results of *neither* versus *both* (Z = -2.699, p = .007), *neither* versus *NN talker's realization* (Z = -2.558, p = .011), and *N talker's realization* and *NN talker's realization* (Z = -2.844, p = .004). However, the results of *neither* versus *N talker's realization* yielded a non-significant difference (Z = -.428, p = .669), again implying that even when there were no N-like realizations in the trials, the American listeners were just as likely to hear the realizations produced by the N talkers as N-like as they were to hear them as NN-like.

Table 13 displays the participants' responses for same trials in the identification of /n/.

Table 13. American listeners' responses for/n/ in the *same* trials

Participants' Responses	Both realization N-like		Neither realization N-like	
	/n/		/n/	
N talker's realization	23	(38.3)	31	(51.7)
NN talker's realization	8	(13.3)	4	(6.7)
Both	**29**	**(48.3)**	5	(8.3)
Neither	0	(0.0)	**20**	**(33.3)**
Total	60	(100.0)	60	(100.0)

Note: n = 60 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

Table 13 shows that in most of the trials in which they did not accurately answer *both*, they chose *N talker's realization* (23 times – 38.3%). They chose the *NN talker's* *realization* only eighth times (13.3%) and they never chose *neither*. Just as for the bilabial nasal, a Friedman test yielded significant differences (X^2 (3, N = 10) = 15.852, *p* = .001). However, whereas the Wilcoxon *post hoc* test confirmed significance between the results of *both* versus *neither* (Z = -2.684, *p* = .007), and *both* versus *NN talker's realization* (Z = -2.209, *p* = .027), it confirmed a non-significant difference between *both* and *N talker's realization* (Z = -852, *p* = .394), meaning that one answer was just as likely as the other. In other words, when the American listeners did not accurately answer *both*, they chose the realization produced by the N talker as N-like, but their choice (or not) of the realization produced by the NN talker was apparently random, as Wilcoxon yielded significance between the results of *N talker's realization* and *NN talker's realization* (Z = -1.853, *p* = .044). As previously discussed for the results of /m/ above, it may indicate that the American listeners based their responses on holistic manner.

As regards the American listeners' responses for *neither* in the identification of word-final /n/, Table 13 also shows that, just as the results of word-final /m/, the percentages of responses for *N talker's realization* were higher than for the accurate response *neither*, 51.7% and 33.3%, respectively, again suggesting that the listeners tended to identify the N talkers' realizations as being N-like, regardless of the realization or not of the final nasal. There were also only five responses for *both* and four for *NN talker's realization*. Friedman showed that differences were significant (X^2 (3, N = 10) = 15.506, *p* = .001). Thus, the Wilcoxon *post hoc* test was run and confirmed significance between the results of *neither* and *both* (Z = -2.388, *p* = .017), *neither* and *NN talker's realization* (Z = -2.217, *p* = .027), and *N talker's realization* and *NN talker's realization* (Z = -2.680, *p* = .007). However, the results of *neither* versus *N talker's realization* resulted in a non-significant difference (Z = -1.127, *p* =

.260), again implying that even when there were no N-like realizations in the trials, the American listeners were just as likely to hear the realizations produced by the N talkers as N-like as they were to hear them as NN-like.

To conclude, taking into consideration the results for the identification of /m/ and /n/ in the *same* trials according to talker, there seems to be a talker effect, as the American listeners tended to identify the realization of the N talker as the only N-like realization when there were two N-like (*both*) or two NN-like (*neither*) realizations of the target nasals. These results explain why the answers *neither* and *both* were the most difficult ones for the American listeners: they had to recognize that both realizations of the target nasal consonants were either N-like or NN-like, in the sense of full realization without noticeable nasalization of the previous vowel.

Considering the overall effect of talker in the identification of the English word-final nasal consonants /m/ and /n/, the results reported above showed that the American listeners of this study tended to identify the realizations by the N talker as N-like, even when they were intentionally produced with the typically Brazilian word-final nasalization. This may indicate that the American listeners perceived the pronunciation in a more holistic manner, thus relying on different perceptual cues, and not only on the absence or presence of the full realization of the word-final nasal consonants, in order to decide whether one of the two realizations they heard was more N-like, or whether the two realizations were either N-like or NN-like. Such results will be further discussed when compared to those of the Brazilian listeners in 6.2.1.3.3.

6.1.1.4 Results of N-like versus NN-like by preceding vowel

Table 14 shows the American listeners' results for the identification of the N-like nasals /m/ and /n/ in word-final position by the preceding vowel (high /ɪ/, medium /ɛ/, or low /æ/) in the N-like versus NN-like Identification Test. The number of responses was based on a total of 8 responses for each of the preceding vowels for each of the 10 participants, resulting in a total of 80 responses per preceding vowel for each nasal consonant.

Table 14. American listeners' results of the identification of the N-like realization of word-final nasals /m/ and /n/ in the N-like versus NN-like Identification test by preceding vowel.

	/m/		/n/	
	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers
/ɪ/	46	57.5	41	51.2
/ɛ/	53	66.2	32	40.0
/æ/	51	63.7	44	56.0

Note: n = 80 for each preceding vowel.

Table 14 shows that the N-like English word-final nasal /m/ was less frequently identified by the American listeners in the context of the high vowel /ɪ/ (57.5%), whereas it was identified with higher but similar frequency in the context of the mid and the low vowels, 66.2 and 63.7%, respectively. Although these results follow the tendency of previous studies of native listeners (Kurowski & Blumstein, 1984; Repp, 1986; Sharf & Ostreicher, 1973; Zee, 1981 cited in Kurowski & Blumstein, 1995; Kluge, 2004), in which a high preceding vowel disfavored the accurate identification of N-like /m/ in word-final position in a N-like versus NN-like Identification test, the

Friedman statistical test showed a non-significant effect for preceding vowel in this study (X^2 (2, N =10) = .813, p = .666).

As regards the identification of the N-like English word-final nasal /n/, Table 14 shows that it was most frequently identified by the American listeners in the context of the low vowel (55%), followed by the context of the high vowel (51.2%), and least frequently identified in the context of the mid vowel (40%). Just as for the /m/, the Friedman statistical test also found a non-significant effect of the preceding vowel for the identification of the N-like /n/ (X^2 (2, N =10) = 4.270, p = .118), but these results follow the tendency of the results of Kluge (2004), in which low preceding vowel favored the accurate identification of N-like /n/ in word-final position in a N-like versus NN-like Identification test.

In summary, as there was not a significant effect for preceding vowel to favor and/or disfavor the identification of N-like /m/ or /n/ in word-final position by the American listeners of this study, it seems that the low scores that they obtained in the N-like versus NN-like identification test were due to the effect of talker. Apparently, even when the N talker was intentionally producing the final nasal as produced in BP, that is, with nasalization of the preceding vowel and omission of the nasal consonant, there were some N-like characteristics of her production which influenced the response of the American listeners.

6.1.2 Three-condition Identification Test

This section reports the American listeners' results in Three-condition Identification Test, in which the participants had to indicate the word-final nasal they heard/saw in the three of the test conditions: *A only* (*A only*), *AV* (*AV*) and *V only* (*V only*).

6.1.2.1 Overall results of Three-condition Identification Test

Table 15 shows the individual results in each of the conditions of the Three-condition test - *A only*, *AV* and *V only* - by the American listeners. There were 24 answers for each of the target nasals in each of the three conditions for each of the participants, resulting in a total of 240 answers for each condition. Just as in the first identification test, the performance of both men and women were not statistically different for /m/ or /n/ in any of the three conditions tested.

Table 15. Number of correct identifications of /m/ and /n/ in each test condition of the Three-condition Identifications test by the American listeners.

	/m/			/n/			/m/ - /n/
Part	*A only*	*AV*	*V only*	*A only*	*AV*	*V only*	Total
1	24	24	24	24	24	24	144
2	24	24	24	24	24	24	144
3	24	24	24	23	24	24	143
4	24	24	24	24	24	24	144
5	24	24	24	23	24	24	143
6	24	24	24	23	24	24	143
7	24	24	24	24	24	24	144
8	24	24	24	23	24	24	143
9	24	24	24	24	24	24	144
10	24	24	24	24	24	24	144
Total	240 (100%)	240 (100%)	240 (100%)	236 (98.3%)	240 (100%)	240 (100%)	1436 (99.7%)

Note: n = 24 for each condition for each participant. N = 240.

The general results show that, in contrast to their poor performance on the N-like versus NN-like Identification Test (56.6%), the performance of the American listeners in the identification of both word-final nasal consonants in all three conditions was nearly perfect (99.7%). These results indicate that, whereas the American listeners might have difficulty identifying a particular NN-like characteristic of English word-final nasals produced by N and NN speakers, they have no difficulty perceiving which word-final nasal they hear when produced by a N speaker.

Table 15 shows that /m/ and /n/ were accurately identified by the American listeners in 100.0% of the realizations in the *AV* and *V only* conditions. However, in the *A only* test condition, /m/ was accurately identified in 100.0% of the realizations, whereas /n/ was accurately identified in 98.3% of the realizations. The Wilcoxon test was run and confirmed that the difference in identification of the two nasal consonants for this test condition test was significant (Z = -2.000, p = .046). Thus, results indicate an effect of place of articulation in the *A only* condition for the identification of nasal consonant by the American listeners.

The Friedman was run to see if the 98.3% score for the alveolar nasal in the *A only* condition was significantly different from the 100.0% scores for this nasal in the other two conditions, and it yielded a significant effect for test condition in the identification of /n/ (X^2 (2, N =10) = 8.000, p = .018. Thus, for American listeners, the *A only* condition significantly disfavored the accurate identification of the English word-final nasal /n/. These results for the American listeners are in the direction of results found for Brazilian learners of English in previous studies (Kluge, 2004), in which results showed that the *A only* condition tended to disfavor the accurate identification of both English word-final nasals compared to the AV condition.

However, in this present study, for the Americans listeners, the *A only* condition disfavored the identification of /n/ in comparison not only to the AV condition, but also to the *V only* condition. This tendency was not found in the identification of the English word-final nasal /m/ because of the perfect performance.

6.1.2.2 Results of Three-condition Identification Test by preceding vowel

With respect to the influence of preceding vowels on the identification of the English word-final nasals /m/ and /n/ by the American listeners, Table 16 shows the number of correct identifications of each of the nasal consonants in the context of three preceding vowels /ɪ/, /ɛ/ and /æ/ in each of the three test conditions. There were 80 responses for each of the preceding vowels for each of the target nasals in each of the three conditions, resulting in a total of 240 answers for each condition.

Table 16. American listeners' results of the accurate identification of word-final nasals /m/ and /n/ by preceding vowel in the Three-condition Identification Test.

	/m/			/n/		
	A only	*AV*	*V only*	*A only*	*AV*	*V only*
/ɪ/	80	80	80	79	80	80
/ɛ/	80	80	80	79	80	80
/æ/	80	80	80	78	80	80

Note: n = 80 for each preceding vowel.

There was obviously no effect for preceding vowel on the identification of /m/ in any condition or for /n/ in the *V only* or the *AV* condition, since in all of these performance was 100.0% accurate. In regard to /n/ in the *A only* condition, Table 12 shows that the American listeners accurately identified the alveolar nasal in 78 realizations in the context of the low vowel /æ/; and in 79 realizations for the mid vowel /ɛ/ and the high vowel /ɪ/. The Friedman test confirmed that these differences were not significant (X^2 (2, N = 10) = .500, p = .779). Thus, the results indicate that, just as for the bilabial consonants, there is no effect of preceding vowel on the identification of English word-final /n/ in any of the three conditions tested. It should be pointed out, though, that even for /n/ the results were near ceiling, which makes significant differences among conditions or contexts extremely difficult to obtain.

6.2 Perception of the Brazilian listeners

6.2.1 N-like versus NN-like Identification Test

6.2.1.1 Overall results of N-like versus NN-like Identification Test

Before addressing the research questions and hypotheses related to the results of the N-like versus NN-like Identification test, the individual results of the Brazilian listeners on the identification of the N-like realization of English word-final /m/ and /n/ will be examined. Table 17 displays the number of correct identifications for each of the target nasals by each of the forty-two participants, including both the *different* and *same* trials.

Table 17. Individual results of the N-like versus NN-like Identification Test by the Brazilian listeners.

	/m/		/n/		/m/ and /n/	
	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers
1	20	83.3	16	66.7	36	76.0
2	19	79.2	9	37.5	28	58.3
3	15	62.5	14	58.3	29	60.4
4	14	58.3	15	62.5	29	60.4
5	18	76.0	14	76.0	32	66.7
6	22	91.7	13	54.2	35	72.9
7	13	54.2	14	58.3	27	56.2
8	19	79.2	18	76.0	37	77.1
9	15	62.5	11	46.8	26	54.2
10	16	66.7	15	62.5	31	64.6
11	16	66.7	11	46.8	27	56.2
12	13	54.2	11	46.8	24	50.0
13	18	76.0	18	76.0	36	76.0
14	20	83.3	15	62.5	35	72.9
15	18	76.0	16	66.7	34	70.8
16	20	83.3	10	41.7	30	62.5
17	16	66.7	10	41.7	26	54.2
18	15	62.5	16	66.7	31	64.6
19	15	62.5	12	50.0	27	56.2
20	17	70.8	16	66.7	33	68.7
21	16	66.7	17	70.8	33	68.7
22	14	58.3	10	41.7	24	50.0
23	12	50.0	11	46.8	23	47.9
24	16	66.7	12	50.0	28	58.3
25	14	58.3	8	33.3	22	46.8
26	20	83.3	19	79.2	39	81.2
27	13	54.2	7	29.2	20	41.7
28	15	62.5	15	62.5	30	62.5
29	16	66.7	13	54.2	29	60.4
30	8	33.3	12	50.0	20	41.7
31	20	83.3	19	79.2	39	81.2
32	15	62.5	15	62.5	30	62.5
33	24	100.0	21	87.5	45	93.7
34	21	87.5	13	54.2	34	70.8
35	11	46.8	7	29.2	18	37.5
36	14	58.3	9	37.5	23	47.9
37	15	62.5	12	50.0	27	56.2
38	21	87.5	15	62.5	36	76.0
39	13	54.2	8	33.3	21	43.7
40	18	76.0	16	66.7	34	70.8
41	22	91.7	18	76.0	40	83.3
42	23	96.8	12	50.0	35	72.9
Total	700	69.4	563	56.8	1263	62.6
	N = 1008		N = 10008		N = 2016	

Note: n = 24 answers for each consonants for each participant.

As specified in the previous chapter, there are an equal number of men and women in the Brazilian group. Although investigating gender is not the focus of this research, the Wilcoxon statistical test revealed was applied and revealed that there was not a significant difference between the performance of men and that of women for either /m/ (Z = -.713, p = .476) or /n/ (Z = - .535, p = .592). This allowed the discarding of gender as a variable, since it indicates that there was no gender effect on the N-like versus NN-like Identification test by the Brazilian listeners, just as for the American listeners.

The overall results, considering both nasal consonants, reveal that the accurate identification of the N-like realizations of the English word-final nasal consonants was difficult for Brazilian listeners, as they correctly identified them in only 62.6% of the trials. However, compared to the performance of the American listeners, who correctly identified the N-like realization of the target nasal consonant in only 56.6% of the trials, the task was less difficult for the Brazilian listeners Nevertheless, the Mann-Whitney U test revealed that this difference in the performance of the two groups is not significant (Z = - 1.384, p = .166), so it can be said that the difficulty was approximately the same for the two groups.

The overall results also show a large degree of variability among the individual scores of the Brazilian listeners, as for those of the Americans, ranging from 37.5% (minimum score) to 93.7% (maximum score). Seven out of the forty-two participants accurately identified the N-like realization in 50% or less of the trials; half of the Brazilian listeners scored within the range of 60-80%, and only four scored more than 80%.

Concerning the identification of the N-like /m/ and /n/ separately, Table 17 shows that the N-like realization of /m/ was accurately identified by the Brazilian listeners in 69.4% of the trials and of /n/ in only 56.8% of the trials. A Wilcoxon test confirmed that this difference was statistically significant (Z = -4.813, *p* = .000). Thus, identification of the bilabial nasals in word-final position was less difficult for the Brazilian learners of English than the identification of the alveolar in the N-like versus NN-like identification test. This parallels the results found for the American listeners.

6.2.1.2 Results of N-like versus NN-like Identification Test by type of trial

The first research question related to this identification test aimed at investigating whether the Brazilian EFL learners would be able to identify the N-like realization of the nasals /m/ and /n/, differing in the presence or absence of a fully realized English pronunciation. As stated in Chapter 5, there were two types of trial in this identification test: *different* trials, where the N-like pronunciation appeared in one of the two positions *1* or *2*, and *same* trials, where either both pronunciations were N-like or both were NN-like. Table 18 displays the Brazilian listeners' overall results regarding type of trial (*same* and *different*) for each of the nasal consonants. The number of correct answers in each cell is based on a total of 504 responses: 12 trials times 42 participants.

Table 18. Brazilian listeners' results by type of trial in the N-like versus NN-like Identification Test.

Nasal consonant	*Different* trials		*Same* trials	
	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers
/m/	401	79.6	299	59.3
/n/	343	68.0	220	43.6

Note: n = 504 for each type of trial for each consonant.

For the identification of the N-like /m/, the results show that the participants obtained higher scores when there was contrast, that is, in *different* trials, where they were accurately perceived in 79.6% of the cases, compared to 59.3% in the *same* trials. The Wilcoxon revealed that the difference between the scores of each type of trial was significant (Z = -4.582, *p* = .000). Thus, in contrast to the results for the American listeners, these results indicate that there was an effect of type of trial in the accurate identification of the N-like realization of /m/ by the Brazilian listeners: *different* trials favored the accurate identification of the word-final bilabial consonant.

As regards the N-like English word-final nasal /n/, Table 18 shows tha it was also less frequently identified by the Brazilian learners in the *same* trials (43.6%) than in the *different* ones (68%). The Wilcoxon test yielded a significant difference (Z = -6.011, *p* = .000). Thus, just as for the native speakers, the results indicate that there was an effect for type of trial: the *same* trials disfavored the accurate identification of the N-like pronunciation of /n/ by the Brazilian listeners. In fact, for the Brazilian group, there was an effect of type of trial in the identification of the N-like realization of both English word-final nasals. Apparently Brazilian learners are better able to identify the N-like realization of English word-final nasals /m/ and /n/ when presented in *different* trials, that is, in contrast, thus, corroborating previous studies (Kluge, 2004, 2007) and supporting Hypothesis 1.

In order to further investigate RQ1 and the influence of the test itself, Tables 19 and 20 show the actual responses of the Brazilian listeners for each of the four possible answers (*1*, *2*, *both* or *neither*) in the identification of /m/ and /n/, respectively. The test contained 48 trials for each participant, 24 for /m/ and /n/. For each nasal, the four possible answers (*1*, *2*, *both* or *neither*) were presented 6 times each. As there were 42 participants, there were 252 responses for each of the four possible answers. Regarding the analysis of /m/, the correct responses and percentages are in bold (Table 19).

Table 19. Brazilian listeners' responses in the identifications of N-like versus NN-like /m/.

Possible answer	Participants' responses for /m/							
	1		*2*		*Both*		*Neither*	
1	**201**	**(79.8)**	21	(8.3)	17	(6.7)	13	(6.2)
2	22	(8.7)	**200**	**(79.4)**	24	(9.5)	6	(2.4)
Both	30	(11.9)	50	(19.8)	**169**	**(67.1)**	3	(1.2)
Neither	56	(22.2)	53	(21.0)	13	(6.2)	**130**	**(51.6)**

Note: n = 252 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

For the identification of the N-like /m/, Table 19 shows that the percentages of correct answers were higher in the *different* trials, when the correct response was either *1* (79.8%) or *2* (79.4%), than in the *same* trials, when the correct response was either *both* (67.1%) or *neither* (51.6%). The Friedman statistical test showed a significant effect for type of possible answer in the identification of N-like realization of English word-final /m/ (X^2 (3, N = 42) = 42.897, p = .000).Wilcoxon *post hoc* tests were run in order to verify which pairs of possible answer were significantly different from each other. As the Brazilian listeners obtained similar scores for *1* and *2*, Wilcoxon yielded a non-significant difference (Z = -.027, p = .978). The test results for the pairs contrasting the possible answers *both* and *neither* with the possible answers *1* and *2* showed significant differences, as follows: *both* versus *1* (Z = -2.477, p = .013), *both* versus *2* (Z = -2.256, p = .024), *neither* versus *1* (Z = -6.200, p = .000), and *neither* versus *2* (Z = -4.958, p = .000). As for the pair *both* versus *neither*, Wilcoxon also yielded significant result (Z = -2.966, p = .003).

Thus, the results indicate that it was more difficult for the Brazilian listeners to perceive that both realizations were either N-like (*both*) or NN-like (*neither*) pronunciations of the word-final nasal /m/ than when only one realization was N-like. These results for the identification of N-like word-final /m/ reinforce Hypothesis 1: the Brazilian learners were better able to identify the N-like realization of the word-final nasals when there was a contrast, that is, in the different trials (those with possible answer *1* or *2*) than when there was none – in the *both* and *neither* trials. Furthermore, when the realizations were the same, they were better able to perceive it when both realizations were N-like than when neither was N-like.

Table 19 also shows that when the Brazilian listeners heard two N-like pronunciations, they either responded correctly (67.1%) or responded *1* (11.9%) or *2* (19.8%); they only responded *neither* when it was *both* three times (1.2%). Furthermore, the table shows that when the Brazilians heard two NN-like realizations of the /m/, they either responded correctly (51.6%) or responded *1* (22.2%) or *2* (21%); they only responded *both* when it was *neither* in 6.2% of the trials. As a result, it seems that when the Brazilian learners of English heard either two N-like or two NN-like pronunciations (*same* trials), they either responded correctly or responded 1 or 2; they rarely responded *neither* when it was *both* or *both* when it was *neither*. This indicates that these participants expected the trials to be *different* trials and guessed at which one was N-like. The results of the American listeners showed the same tendency.

Regarding the analysis of /n/, Table 20 shows that Brazilian listeners' responses and percentages for each of the four possible responses. The correct responses are in bold.

Table 20. Brazilian listeners' responses in the identifications of N-like versus NN-like /n/.

Possible answer	Participants' responses for /n/							
	1		*2*		*Both*		*Neither*	
1	**168**	**(66.7)**	39	(16.5)	31	(12.3)	14	(6.5)
2	39	(16.5)	**175**	**(69.4)**	28	(11.1)	10	(4.0)
Both	45	(17.9)	71	(28.2)	**129**	**(51.2)**	7	(2.8)
Neither	76	(30.2)	67	(26.6)	18	(7.1)	**91**	**(36.1)**

Note: n = 252 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

Table 20 reveals the same tendency found for /m/: the total percentages of correct answers were higher in the *different* trials, when the correct response was either *1* (66.7%) or *2* (69.4%), than in the *same* trials, when the correct response was either *both* (51.2%) or *neither* (36.1%). Thus, *neither* was the type of response in which the Brazilian and the American listeners obtained the lowest scores in the identification of N-like /m/ and /n/.

The Friedman statistical test was run and yielded a significant effect for type of possible answer in the identification of N-like realization of /n/ (X^2 (3, N = 42) = 40.282, p = .000) by the Brazilian learners. Wilcoxon tests were run in order to verify which pairs of possible answer were statistically significant and revealed that results were the same for /m/ and /n/. As the Brazilian learners obtained similar scores for *1* and *2*, Wilcoxon showed that the difference was not significant (Z = -.989, p = .323). The lack of significant difference also shows that there was no position effect, thus validating the results of this perception test. The results for the pairs contrasting the possible answers *both* and *neither* with the possible answers *1* and *2* revealed significant differences: *both* versus *1* (Z = -2.444, p = .015), *both* versus *2* (Z = -3.063, p = .002), *neither* versus *1* (Z = -6.222, p = .000), and *neither* versus *2* (Z = -4.982, p = .000). Wilcoxon also showed a significant result for the pair *both* versus *neither* (Z = -2.431, p

= .015). Hence, results indicate that it was difficult for the Brazilian learners to perceive that both realizations were either N-like or NN-like pronunciations of the alveolar nasal consonant in word-final position. These results for the alveolars are in the same direction of those of the bilabials, thus, also supporting the hypothesis of the RQ1 which predicted that the Brazilian learners would be better able to identify the N-like realization of those nasal consonants when presented in contrast.

Table 20 also shows that when the Brazilian listeners heard two N-like pronunciations (*both*), they either responded correctly (51.2%) or responded *1* (17.9%) or *2* (28.2%); they only responded *neither* when it was *both* in 2.8% of the trials. Moreover, when the Brazilian listeners heard two NN-like realizations of the target bilabial (*neither*), they either responded correctly (36.1%) or responded *1* (30.2%) or *2* (26.6%); they only responded *both* when it was *neither* in 7.1% of the trials. Thus, results indicate that when the Brazilian learners of English heard either two N-like or two NN-like pronunciations, they either responded correctly or responded *1* or *2*; they rarely responded *neither* when it was *both* or *both* when it was *neither*. As the same tendency was found for the identification of both word-final nasal /m/ and /n/ for both American and Brazilian groups, it can be said that all the participants of this study expected the trials to be *different* trials and guessed at which one was N-like when they were the same. Furthermore, these findings not only support the hypothesis stated for RQ1 as regards the Brazilian learners, but also show that the American listeners followed the same hypothesis.

6.2.1.3 Results of N-like versus NN-like Identification Test by talker and type of realization

6.2.1.3.1 Identification of /m/ and /n/ in *different* trials

As shown in 6.1.1.3.1, results indicate a talker effect for the American listeners in the identification of the N-like word-final /m/ and /n/. In order to investigate whether there is also a talker effect for the Brazilian listeners, Tables 21 and 22 display their responses according to talker (Table 21) and type of realization (Table 22) for /m/ and /n/, respectively. In order to do so, the participants' responses were grouped according to N-like or NN-like realization disregarding the trial position, either *1* or *2,* and *both* and *neither.* As the participants were instructed to choose the most American N-like pronunciation, the correct response would be the N-like realization produced by either the N talker or the NN talker. Therefore, in Tables 21 and 22, there are four possible participants' response types: correct N-like realization (*correct N-like realization*), incorrect NN-like realization (*incorrect NN-like realization*), *both* or *neither*. The number of participants' responses in each table was based on the total 252 trials for each of the 4 possible answers, resulting in a total of 1008 responses in each table.

Table 21. Brazilian listeners' responses for /m/ in the *different* trials according to talker and type of realization.

Participants' Responses	N-like realization by N talker /m/		N-like realization by NN talker /m/	
Correct N-like realization	**194**	**(77.0)**	**207**	**(82.1)**
Incorrect NN-like realization	23	(9.1)	20	(7.9)
Incorrect Both	24	(9.5)	17	(6.7)
Incorrect Neither	11	(4.4)	8	(3.2)
Total	60	(100.0)	60	(100.0)

Note: n = 252 for each response; correct participant responses in bold. Percentages are in parentheses.

Table 21 shows that the Brazilian listeners, surprisingly, obtained higher scores of accurate identification of N-like realization of the word-final /m/ when it was pronounced by the NN talker (82.1%) than when produced by the N talker of English (77%). However, Wilcoxon showed that this difference is not significant (Z = -1.243, p = .214). Thus, results indicate that, differently from the American listeners, there is no talker effect for the Brazilian learners in the identification of the N-like realization of /m/.

As regards the Brazilian listeners' responses for the identification of the N-like realization of /m/ produced by the N talker, Table 21 also shows that when they did not accurately identify the N-like production by the N talker, there were only 23 responses for the NN-like realization (9.1%), 24 for *both* (9.5%), and 11 responses for *neither* (4.4%). A Friedman test confirmed significant differences (X^2 (3, N = 42) = 86.003, p = .000), and a Wilcoxon *post hoc* test showed significance between the results of *N-like realization* produced by the N talker and all three other possible responses: *nonnative realization* by the NN talker (Z = -6.518, p = .000), *both* (Z = -6.546, p = .000), and *neither* (Z = -6.617, p = .000). Thus, the results confirm that the identification of the N-like realization of word-final /m/ produced by the N talker by the Brazilian group was significantly more likely to be identified as such than as any other possible answer.

Table 21 also shows that the Brazilian learners accurately identified the N-like realization by the NN talker in 82.1% of the trials. They chose the NN-like realization by the N talker in 7.9% of the trials, *both* in 6.7% of the trials, and *neither* in only 3.2% of the trials. The Friedman test revealed the differences are significant (X^2 (3, N = 42) = 94.733, p = .000). Wilcoxon *post hoc* test confirmed significance between the results of *N-like realization* by the NN talker and all three other possible responses: *nonnative realization* by the N talker (Z = -6.591, p = .000), *both* (Z = -6.603, p = .000), and *neither* (Z = -6.728, p = .000). Thus, the results confirm that regardless of whether the N-like realization of word-final /m/ was produced by the native or NN talker, the Brazilian listeners were significantly more likely to identify it as such than to choose any other incorrect response.

Table 22 below displays the results for the identification of /n/ in the *different* trials according to talker and type of realization. The correct responses are in bold.

Table 22 Brazilian listeners' responses for /n/ in the *different* trials according to talker and type of realization.

Participants' Responses	N-like realization by N talker /n/		N-like realization by NN talker /n/	
Correct N-like realization	**194**	**(77.0)**	**149**	**(59.2)**
Incorrect NN-like realization	24	(9.5)	54	(21.4)
Incorrect Both	22	(8.7)	37	(14.7)
Incorrect Neither	12	(4.8)	12	(4.8)
Total	60	(100.0)	60	(100.0)

Note: n = 252 for each response; correct participant responses in bold. Percentages are in parentheses.

The table shows that the Brazilian listeners obtained higher scores when /n/ was produced by the N talker (77%) than when produced by the NN talker (59.2%). A Wilcoxon test was run and yielded a significant difference (Z = -3.123, *p* = .002). Thus, results indicate that, just as for the American listeners but differently from the bilabial nasal, there is a talker effect for the Brazilian learners as the identification of the N-like word-final /n/ produced by the N talker was more easily identified by them than when it was produced by the NN talker.

Table 22 also shows that when the Brazilians did not accurately identify the N-like production by the N talker they chose the incorrect responses a few times: 22 as *Incorrect NN-like realization* (9.5%), 22 as *both* (8.7%), and 12 as *neither* (4.8%). A Friedman test showed the differences were significant (X^2 (3, N = 42) = 88.427, *p* = .000), and a Wilcoxon *post hoc* test showed significance between the results of *N-like realization* by the N talker and all three other possible responses: *Incorrect NN-like realization* by the NN talker (Z = -6.676, *p* = .000), *both* (Z = -6.609, *p* = .000), and *neither* (Z = -6.657, *p* = .000). Thus, the results confirm that the identification of the N-like realization of /n/ produced by the N talker was considerably more likely to be identified as such than as any other incorrect response by the Brazilian group.

When the Brazilian learners did not accurately identify the N-like realization of /n/ by the NN talker, they chose the NN-like realization by the N talker in 21.4% of the trials, *both* in 14.7% of the trials, and *neither* in only 4.8% of the trials. As the Friedman test yielded significant differences (X^2 (3, N = 42) = 56.102, *p* = .000), Wilcoxon *post hoc* test was run and confirmed significance between the results of *N-like realization* by the NN talker and all three other possible responses: *N-like realization* by the N talker (Z = -3.909, *p* = .000), *both* (Z = -4.777, *p* = .000), and *neither* (Z = -6.328, *p* = .000).

Hence, the results confirm that when the N-like realization of word-final /n/ was produced by the NN talker, the Brazilian listeners were significantly more likely to identify it as N-like than as any other incorrect response.

Now comparing the performance of the American and Brazilian groups in *different* trials as regards talker, results show a strong talker effect for the American listeners in the identification of the N-like realizations of both nasals, as they identified the N-like realization by the NN talker in less than half of the trials. Results also show that the American listeners tended to identify as N-like realization the NN realization produced by the N talker, or to consider both realizations as N-like ones by choosing the answer *both*. On the other hand, the Brazilian listeners showed a talker effect only in the identification of the N-like /n/, as they obtained higher scores when it was produced by the N talker.

Tables 23 and 24 allow visualization of the different performance of the two groups on the identification of N-like realizations of /m/ and /n/, respectively, produced by the N talker and the NN talker in *different* trials.

Table 23. Percentages, mean, median, and Standard Deviation (*SD*) of correct answers for /m/ by the American group (AG) and Brazilian group (BG) in *different* trials as regards talker.

	N-like realization by the N talker				N-like realization by the NN talker			
	/m/				/m/			
	%	Mean	Median	*SD*	%	Mean	Median	*SD*
AG	96	5.7	6.0	*.4*	46	2.7	3.0	*1.9*
BG	77	4.6	5.0	*1.2*	82.1	4.9	5.0	*1.3*

Table 24. Percentages, mean, median, and Standard Deviation (*SD*) of correct answers for /n/ by the American group (AG) and Brazilian group (BG) in *different* trials as regards talker.

	N-like realization by the N talker				N-like realization by the NN talker			
	/n/				/n/			
	%	Mean	Median	*SD*	%	Mean	Median	*SD*
AG	89	4.8	5.0	*1.2*	33.3	2.0	1.5	*1.8*
BG	77	4.6	5.0	*1.1*	59.2	3.5	4.0	*1.6*

It can be observed that, in the identification of the target nasal consonants produced by the N talker, the Americans outperformed the Brazilians in both word-final nasals. A Mann-Whitney U test revealed that the differences in the performance are significant for /m/ (Z = - 2.611, *p* = .009), but not significant for /n/ (Z = - 675, *p* = .499). Interestingly, in the identification of the nasal consonants produced by the NN talker, the Brazilian group outperformed the Americans on both nasals. A Mann-Whitney U test yielded significance in the differences for both /m/ (Z = - 3.407, *p* = .001) and /n/ (Z = - 2.391, *p* = .017). In general, results indicate that it was easier for the American listeners to accurately identify the N-like realization of word-final /m/ and /n/ when it was produced by the N talker, whereas for the Brazilian listeners it was easier to identify the N-like realization of only one of the nasal consonants produced by the NN talker—the /m/.

6.2.1.3.2 Identification of native-like /m/ and /n/ in *same* trials

Table 25 and 26 show the responses of the Brazilian listeners for the *same* trials, when the correct answers were either *both* or *neither* for the identification of /m/ and /n/, respectively, regarding type of realization. As explained in 6.1.3.2, for the *both* trials, there were four possible answers: the correct response *both*, and three other incorrect responses (*1, 2* and *neither*). For the *neither* trials, there were four possible answers: the correct response *neither* and three other incorrect responses (*1, 2* and *both*). If the correct answer was *both,* for example, consequently any other answer was computed as incorrect. However, for examining whether there was a talker effect within the incorrect responses (which could be either *1, 2* or *neither*), the researcher analyzed the listeners' responses when they chose *1* and *2* only, a response that would show that they may have judged one of the talkers' production as more N-like even when both were supposed to be perceived as N-like. The reasoning is that if the participants cannot perceive that both realizations are N-like and kept repeating a pattern in choosing one of the talkers, then the stimuli produced by this particular talker was biasing the listeners' perception, that is, there was a talker effect on the choice of the responses. The same reasoning was done for the *neither* trials.

Tables 25 and 26 show the participants' responses for the identification of /m/ and /n/ respectively, when the correct response was either *both* or *neither*. For both the incorrect participants' responses were named *N talker's realization* and *NN talker's realization,* and *neither*, whereas for neither the incorrect participants' responses were named *N talker's realization* and *NN talker's realization,* and *both.*

Table 25. Brazilian listeners' responses for/m/ in the *same* trials

Participants' Responses	Both realization N-like		Neither realization N-like	
	/m/		/m/	
N talker's realization	36	(14.3)	47	(18.6)
NN talker's realization	44	(17.5)	62	(24.6)
Both	**169**	**(67.1)**	13	(5.2)
Neither	3	(1.2)	**130**	**(51.6)**
Total	60	(100.0)	60	(100.0)

Note: n = 252 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

As discussed in 6.2.1.2., the identification of the N-like realization in *both* trials was significantly easier for the Brazilian listeners than the *neither* trials. Thus, examination of the kinds of errors made might shed some light on this difference. Table 25 shows that in most of the trials in which they did not accurately identify that both pronunciations of /m/ were N-like, they chose the *N talker's realization* in 14.3% of the trials, the *NN talker's realization* in 17.5% of the trials, and *neither* in only 1.2% of the trials. The Friedman test showed that the differences were significant (X^2 (3, N = 42) = 71.591, *p* = .000), and the Wilcoxon *post hoc* test confirmed significance between the results of *both* and all three other possible responses: *N talker's realization* (Z = -5.014, *p* = .000), *NN talker's realization* (Z = -4.688, *p* = .000), and *neither* (Z = -5.544, *p* = .000). As for the results of *N talker's realization* and *NN talker's realization*, Wilcoxon revealed that the difference is not statistically significant (Z = -.712, *p* = .476), a result that indicates that Brazilian listeners do not favor the realization of any of the talkers when they hear N-like realization in the *both* trials. In fact, the results show that the two N-like realizations of word-final /m/ were significantly more likely to be accurately identified as *both* (N-like realizations) than as any other possible answer by the Brazilian learners of English. This results are quite different from those of the American listeners who seemed to have favored the N talker's realization of /m/ when they did not accurately answer *both.*

As for *neither*, Table 25 reveals that in most of the trials in which the Brazilians did not accurately perceive that neither of the realizations of word-final /m/ was N-like, they chose the *N talker's realization* in 18.6% of the trials, *NN talker's realization* in 24.6% of the trials, and *both* in only 5.2% of the trials. The Friedman test yielded significant differences(X^2 (3, N = 42) = 46.678, *p* = .000). The Wilcoxon test confirmed significance between the results of *neither* and all three other possible responses: *N talker's realization* (Z = -4.326, *p* = .000), *NN talker's realization* (Z = -4.054, *p* = .000), and *both* (Z = -5.276, *p* = .000).). The comparison between the results of *N talker's realization* and *NN talker's realization* is not significant, as shown by Wilcoxon (Z = -1.211, *p* = .226), a result that indicates that Brazilian listeners do not favor the realization of any of the talkers when they hear NN-like realization in the *same* trials. In fact, the results show that the two NN-like realizations of word-final /m/ were significantly more likely to be accurately identified as *neither* than as any other incorrect response by the Brazilian learners of English. On the other hand, the American listeners seemed to have favored the N talker's realization of /m/ when they did not accurately answer *neither,* a result that parallels those of the analysis of the *both* trials discussed above.

Table 26 displays the Brazilian listeners' responses for the *same* trials in the identification of /n/.

Table 26. Brazilian listeners' responses for/n/ in the *same* trials

Participants' Responses	Both realization N-like		Neither realization N-like	
	/n/		/n/	
N talker's realization	62	(24.6)	101	(40.2)
NN talker's realization	54	(21.4)	42	(16.7)
Both	**129**	**(51.2)**	18	(7.1)
Neither	7	(2.8)	**91**	**(36.1)**
Total	60	(100.0)	60	(100.0)

Note: n = 252 for each possible answer; correct participant responses in bold. Percentages are in parentheses.

The table shows that in most of the trials in which the Brazilian listeners did not accurately perceive that both pronunciations of /n/ were N-like realizations, they chose the *N talker's realization* in 24.6% of the trials, the *NN talker's realization* in 21.4% of the trials, and *neither* in only 2.8% of the trials. The Friedman test yielded significant differences (X^2 (3, N = 42) = 40.784, p = .000). The Wilcoxon *post hoc* test revealed significance between the results of *both* and all three other possible responses: *N talker's realization* (Z = -2.931, p = .003), *NN talker's realization* (Z = -3.383, p = .001), and *neither* (Z = -5.094, p = .000).). As for the results of *N talker's realization* and *NN talker's realization,* Wilcoxon yield a non-significant difference (Z = -.498, p = .619), a result that suggests that Brazilian listeners do not favor the realization of any of the talkers when they hear N-like realization in the *both* trials. Actually, the two N-like realizations of /n/ were significantly more likely to be accurately identified as *both* (N-like realizations) than as any other possible answer by the Brazilian learners of English. This is quite different from the American listeners, who seemed to favor the *N talker's realization* of word-final /n/ when they did not accurately answer *both*.

As for the types of error when the correct answer was *neither* in the identification of N-like word-final /n/, Table 26 shows that the percentage of responses by the Brazilian listeners for *N talker's realization* was higher than for the accurate response *neither*, 40.1% compared to 36.1%, respectively. They also chose the *NN talker's realization* and *neither* in 16.7% and 7.2% of the trials respectively. The Friedman confirmed that differences were significant (X^2 (3, N = 42) = 46.678, p = .000). Wilcoxon showed significance between the results of *neither* and two other possible responses: *neither* versus *both* (Z = -4.815, p = .000), and *neither* versus *NN talker's realization* (Z = -3.052, p = .002). However, the comparison *neither* versus *N talker's realization* resulted in a non-significant difference (Z = -358, p = .721). Thus, contrary to the /m/, but similar to the American listeners, there was a talker effect in the identification of the N-like /n/ by the Brazilian listeners in the *neither* trials: they were more likely to choose the N talkers' realization of /n/ as N-like than to correctly identify both realizations as NN-like.

6.2.1.3.3 Overall effect of talker in the identification of N-like /m/ and /n/ for the American and Brazilian listeners.

An overall comparison of the performance of the American and the Brazilian groups in *same* trials shows that the American listeners were more influenced by the native talker realization of /m/ and /n/ than the Brazilian listeners. In general, in the *same* trials, the American listeners demonstrated a rather strong tendency to choose the N talkers' realization as the correct one, rather than identify both realizations as either N-like or NN-like. The Brazilian listeners, on the other hand, had a much weaker talker effect, more frequently identifying both realizations of /m/ and /n/ as either N or NN-like ones and demonstrating a bias for the N talker only in the *neither* trials for /n/. This, in fact, was the only condition in which there was a native talker bias for both the American and the Brazilian group

Tables 27 and 28 display the percentages, means, medians, and standard deviations of accurate answers for /m/ and /n/ respectively, by the American and Brazilian listeners in the *same* trials.

Table 27. Percentages, mean, median, and Standard Deviation (*SD*) of correct answers for /m/ by the American group (AG) and Brazilian group (BG) in *same* trials.

	Both realizations N-like				Neither realization N-like			
	/m/				/m/			
	%	Mean	Median	*SD*	%	Mean	Median	*SD*
AG	66	3.9	4.5	*2.0*	46	2.7	3.0	*1.4*
BG	67	4.0	4.0	*1.7*	51.6	3.1	3.0	*1.3*

Table 28. Percentages, mean, median, and Standard Deviation (*SD*) of correct answers for /n/ by the American group (AG) and Brazilian group (BG) in *same* trials.

	Both realizations N-like				Neither realization N-like			
	/n/				/n/			
	%	Mean	Median	*SD*	%	Mean	Median	*SD*
AG	48.3	2.9	3.0	*1.5*	33.3	2.0	2.0	*1.4*
BG	51.2	3.1	3.0	*2.0*	36.1	2.2	2.0	*1.3*

The tables show that the Brazilian group outperformed the American group in the identification of both /m/ and /n/ in both types of *same* trials – *both* and *neither*. However, a Mann-Whitney U test showed that the differences in the performance of the groups are not significant for /m/ (Z = - 473, p = .566) or for /n/ (Z = - .431, p = .666) in the *both* trials, or for either nasal in the *neither* trials: /m/ (Z = - 130, p = .896) or /n/ (Z = - .317, p = .751). Thus, although the two groups differed in their types of error, they can be considered to have had the same degree of difficulty in identifying the N-like realizations of the word-final nasals /m/ and /n/.

As to type of error, the tables also show that the American group demonstrated a greater talker effect than the Brazilian group, identifying more frequently the N-like word-final /m/ and /n/ produced by the N talker than those produced by the NN talker. There are some possible reasons for these results, having to do with the characteristics of the American listeners of this study, as well as the nature of the stimuli used in N-like versus NN-like identification test.

Regarding the American listeners of this study, the tendency for the N talkers to favor the N-like pronunciation may be due to the fact that they have had had little exposure to any foreign language and had never been exposed to BP; thus they were not used to the Brazilian accent in English. Results for the same Native-like versus Nonnative-like Identification Test from Kluge's previous study (2004) showed that a group of three American listeners who had lived in Brazil from three months to two years at the time of data collection accurately identified the N-like realizations of word-final /m/ and /n/ in 75.8% of the trials, compared to only 55.6% for the American listeners of this study. Thus, it is quite likely that exposure to BP affects the identification of the N-like /m/ and /n/ in word-final position, especially since N-like, in this test, refers specifically to the lack of the Brazilian tendency to omit the nasal consonant and nasalize the preceding vowel. The English native speakers of the previous study, familiar enough with the Brazilian accent to know that this is a typical characteristic, would have been likely to focus on this, whereasa native speakers not familiar with the Brazilian accent, such as those of the present study, would probably listen more holistically and rely on other perceptual cues in the Brazilian talker's realizations, such as spectral or durational characteristics of the vowels, intonation, or even voice quality. On the other hand, as the Brazilian listeners are learners of English, they are more used to the Brazilian accent in English, which may explain the fact that the *N talker's realization* did not influence much their identification of the N-like word-final nasals, as it did for the American listeners.

If the American listeners may have relied on different perceptual cues, then the nature of the stimuli used for the purpose of this test has to be analyzed. Despite the fact that both N and NN talkers of English who recorded the stimuli were phonetically trained and were proficient in both English and BP, results may suggest that their realizations were probably different. The N talker of English may have been better able to better maintain the English spectral quality of the vowel even while nasalizing it, due to the conscious manner in which she would have learned the pronunciation of the Portuguese nasal vowels, than the nonnative talker, whose mental representations of the BP nasal vowels would be stronger, having been acquired in childhood. However, this possibility does not invalidate the results of this study, since the Brazilian and the American groups had a similar overall performance in the identification of N-like realization of the English word-final nasals /m/ and /n/.

6.2.1.4 Results of N-like vs. NN-like Identification Test by preceding vowel

The other research question of the related to the N-like vs. NN-like Identification test is RQ 2, which aimed at investigating whether the height of the preceding vowel would influence the Brazilian EFL learners' identification of the N-like realization of the word-final /m/ and /n/. The hypothesis stated that a low preceding vowel would favor and a high preceding vowel disfavor the accurate identification of the *N-like* realization of /m/ and /n/ in word-final position in the N-like vs. NN-like Identification test.

Table 29 displays the Brazilian listeners' results of the identification of the nasals /m/ and /n/ in word-final position by the preceding vowel (high /ɪ/, medium /ɛ/ or low /æ/). The number of responses was based on a total of 8 responses for each of the preceding vowels for each of the 42 participants, resulting in a total of 336 responses per preceding vowel for each nasal consonant.

Table 29. Brazilian listeners' results of the identification of the N-like realization of word-final nasals /m/ and /n/ by preceding vowel in the N-like vs. NN-like Identification Test.

	/m/		/n/	
	No. Correct Answers	% Correct Answers	No. Correct Answers	% Correct Answers
/ɪ/	198	58.9	149	44.3
/ɛ/	234	69.6	179	53.3
/æ/	268	79.8	235	69.9

Note: n = 336 for each preceding vowel.

Table 29 shows that the accurate identification of the N-like English word-final nasal /m/ by the Brazilian listeners increased from the context of preceding high vowel (58.9%) to the mid vowel (69.6%) to the low vowel (79.8%). The Friedman statistical test was run and revealed a significant effect for preceding vowel followed by /m/ (X^2 (2, N = 42) = 23.700, p = .000). The Wilcoxon test revealed significance between the results of all three pairs: the high vowel /ɪ/ vs. the mid vowel /ɛ/ (Z = -2.574, p = .010) and the low vowel /æ/ (Z = -4.689, p = .000), and the mid vowel /ɛ/ vs. the low vowel /æ/ (Z = -2.608, p = .009). These significant differences confirm Hypothesis 2, which said that the low preceding vowel would favor and the high preceding vowel disfavor the accurate identification of N-like /m/, corroborate the findings of previous studies (Kluge, 2004).

As for /n/, Table 29 shows that the results followed the same tendency as for /m/; that is, the correct identification by the Brazilian listeners also increased from the context of preceding high vowel to the mid vowel to the low vowel, 44.3%, 53.3%, 69.9% respectively. For this nasal consonant also, the Friedman test showed a significant effect for preceding vowel (X^2 (2, N = 42) = 23.228, p = .000), and the

Wilcoxon yielded significance between all the three vowel pairs: the high vowel /ɪ/ versus the mid vowel /ɛ/ (Z = -2289, p = .022) and the low vowel /æ/ (Z = -4.379, p = .000), and the mid vowel /ɛ/ versus the low vowel /æ/ (Z = -3.818, p = .000). Thus, the results for /n/, as well as for /m/, indicate that a high preceding vowel disfavors and a low preceding vowel favors the accurate identification of the N-like realization of those nasal consonants, confirming Hypothesis 2 and corroborating the findings of previous studies (Kluge, 2004). It should be remembered from section 6.1.1.4 that this effect for the preceding vowel was not found for the American group. The results may suggest that, probably the talker effect for the American listeners was too strong to allow for a vowel effect, whereas the talker effect was quite small for the Brazilian listeners.

6.2.2 Three-condition Identification Test

6.2.2.1 Overall results of the Three-condition Identification Test

The Three-condition Identification Test aimed at investigating the third research question, regarding which of the three conditions – *A only* , *AV* , and *V only* – would favor the accurate identification of the English nasal /m/ and /n/ in word-final position by the Brazilian learners. Table 30 displays the individual results in each of the conditions tested. Individual scores (raw data) and percentages are based on 24 responses per target nasal in each condition. Column totals are based on these 24 responses times forty-two participants, giving 1008 responses for each condition. Although investigating gender is not the focus of this research, the Wilcoxon statistical test yielded no significant difference between the performance of men and women for

/m/ in the *A only* (Z = -.598, p = .550) and the *AV* condition (Z = -1.065, p = .287), but a significant difference in the *V only* condition (Z = -2.377, p = .017). The table shows that the women (the first 21 listeners on Table 30) were slightly better than men (the remaining 21 listeners), as women accurately identified the /m/ in *V only* condition in 97.7%, whereas men obtained 95.4%. It is somewhat surprising to find the significant difference, as both percentages was so close to ceiling, but apparently the women participants were more attentive to watching the speaker's lips during the video of the /m/. For /n/, the Wilcoxon test yielded no significant difference in any of the three conditions: *A only* (Z = -.188, p = .851), *AV* (Z = -1.065, p = .287), and *V only* (Z = -.431, p = .667).

The overall results show that the percentage of accurate identification of both nasal consonants gradually increased from *A only* to *V only* to *AV* condition. Table 30 also shows that only two participants (5 and 11) scored 100% in all of the three test conditions for both nasals. As for the identification of both /m/ and /n/, twenty-five and twenty-seven participants respectively scored 100% in the *AV* and *V only* conditions, whereas only four participants (5, 11, 26 and 34) scored 100% in the identification of both word-final nasal consonants in the *A only* condition.

Table 30. Number of correct identifications of /m/ and /n/ in each condition of the Three-condition Identifications Test by the Brazilian listeners.

	/m/						/n/					
.	*A only*		*AV*		*V only*		*A only*		*AV*		*V only*	
	RD	%	RD	%	RD	%	RD	%	RD	%	RD	%
1	22	91.7	24	100.0	24	100.0	20	83.3	24	100.0	24	100.0
2	20	83.3	23	95.8	23	95.8	19	79.2	24	100.0	24	100.0
3	22	91.7	23	95.8	24	100.0	19	79.2	24	100.0	24	100.0
4	17	70.8	19	79.2	23	95.8	11	45.8	23	95.8	24	100.0
5	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0
6	17	70.8	24	100.0	24	100.0	22	91.7	24	100.0	24	100.0
7	23	95.8	24	100.0	24	100.0	22	91.7	24	100.0	24	100.0
8	19	79.2	24	100.0	24	100.0	18	75.0	23	95.8	24	100.0
9	22	91.7	22	91.7	17	70.8	18	75.0	22	91.7	15	62.5
10	21	87.5	24	100.0	24	100.0	23	95.8	24	100.0	24	100.0
11	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0
12	18	75.0	24	100.0	24	100.0	19	79.2	24	100.0	24	100.0
13	24	100.0	23	95.8	24	100.0	23	95.8	24	100.0	24	100.0
14	23	95.8	24	100.0	24	100.0	22	91.7	24	100.0	24	100.0
15	24	100.0	23	95.8	24	100.0	22	91.7	24	100.0	23	95.8
16	17	70.8	23	95.8	23	95.8	10	41.7	24	100.0	23	95.8
17	21	87.5	24	100.0	24	100.0	15	62.5	24	100.0	24	100.0
18	23	95.8	24	100.0	24	100.0	24	100.0	24	100.0	23	95.8
19	24	100.0	24	100.0	24	100.0	23	95.8	24	100.0	24	100.0
20	21	87.5	24	100.0	23	95.8	22	91.7	24	100.0	22	91.7
21	24	100.0	23	95.8	24	100.0	21	87.5	24	100.0	24	100.0
22	17	70.8	22	91.7	23	95.8	18	75.0	23	95.8	23	95.3
23	23	95.8	24	100.0	22	91.7	24	100.0	24	100.0	24	100.0
24	21	87.5	21	87.5	24	100.0	24	100.0	21	87.5	24	100.0
25	18	75.0	24	100.0	21	87.5	15	62.5	24	100.0	24	100.0
26	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0
27	18	75.0	18	75.0	23	95.8	17	70.8	17	70.8	21	87.5
28	23	95.8	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0
29	17	70.8	24	100.0	22	91.7	12	50.0	24	100.0	24	100.0
30	17	70.8	23	95.8	16	66.7	14	58.3	24	100.0	14	58.3
31	22	91.7	24	100.0	22	91.7	21	87.5	24	100.0	24	100.0
32	19	79.2	23	95.8	24	100.0	21	87.5	22	91.7	24	100.0
33	23	95.8	21	87.5	22	91.7	21	87.5	24	100.0	18	75.0
34	24	100.0	23	95.8	24	100.0	24	100.0	24	100.0	24	100.0
35	24	100.0	24	100.0	22	91.7	17	70.8	24	100.0	24	100.0
36	20	83.3	22	91.7	24	100.0	18	75.0	23	95.8	24	100.0
37	21	87.5	23	95.8	24	100.0	18	75.0	24	100.0	24	100.0
38	19	79.2	24	100.0	24	100.0	23	95.8	24	100.0	24	100.0
39	23	95.8	24	100.0	24	100.0	23	95.8	24	100.0	24	100.0
40	23	95.8	24	100.0	24	100.0	22	91.7	24	100.0	24	100.0
41	23	95.8	24	100.0	24	100.0	24	100.0	24	100.0	24	100.0
42	23	95.8	24	100.0	24	100.0	23	95.8	24	100.0	24	100.0
Tot	892	88.5	976	96.8	974	96.6	848	84.1	990	98.2	974	96.6

Note: n = 24 answers for each condition for each nasal consonant by each participant. N = 1008. Percentages are in parentheses. RD: Raw data

The accurate identification of /m/ and /n/ can be compared in each of three conditions in Table 30, which shows that: (a) in the *A only* test condition, /m/ was accurately identified in 88.5% of the tokens, whereas /n/ was accurately identified in 84.1% of the tokens, (b) in the *AV* test condition, /m/ was correctly identified in 96.8% of the tokens, whereas /n/ was accurately identified in 98.2%, and (c) in the *V only* test condition, /m/ and /n/ were correctly identified in 96.6% of the tokens. Although there appears to be an advantage for /m/ in two of the three conditions, the Wilcoxon found no significant difference between the two nasals in any of the three conditions: *A only* (Z = -2.353, p = .19), *AV* (Z = -2.398, p = .16), and *V only* (Z = -.160, p = .873). Thus, there was no nasal consonant effect in the any of the conditions of Three-condition Identification Test for the Brazilians, different from those of the American listeners, in which a nasal consonant effect was found favoring the /m/ the *A only* condition.

As for /m/, the Friedman statistical test showed a significant effect for test condition (X^2 (2, N = 42) = 26.283, p = .000). The Wilcoxon *post hoc* tests confirmed significance between the results of *A only* versus *AV* (Z = -.4.315, p = .000) and *A only* versus *V only* (Z = -.4.018, p = .000), but not between *AV* versus *V only* (Z = -.049, p = .961). In fact, the scores in these two test conditions were nearly the same: 96.8 and 96.6% respectively.

These results indicate that the *A only* test condition disfavored the accurate identification of the English word-final nasal /m/, corroborating the tendency found in previous studies (Hazan et al., 2006, Kluge 2007) and supporting the second hypothesis of RQ 3. However, in this study, the *A only* test condition disfavored the Brazilian listeners' identification of /m/l when compared not only to *AV*, but also to *V only*. The same tendency was found for the American listeners of this study.

Results also indicate that the two test conditions with visual cues (*AV* and *V only*) favored the accurate identification of word-final /m/ by the Brazilian listeners. These results support the first hypothesis of RQ 3, which stated that *AV* would favor the accurate identification of /m/ and corroborate Hazan et al. (2006) and Kluge (2007). Moreover, they demonstrate the importance of visual input even more than those studies, as even the *V only* condition favored identification compared to the *A only* condition.

As regards the identification of /n/ by the Brazilian listeners, the Friedman test revealed a significant effect for test condition (X^2 (2, N =42) = 43.345, p = .000). The Wilcoxon *post hoc* tests confirmed significance between the results of *A only* versus *AV* (Z = -.4.748, p = .000) and *A only* versus *V only* (Z = -.4.304, p = .000), but again not between *AV* versus *V only*: (Z = -. 601, p = .548). Just as for /m/, the results indicate that the *A only* test condition disfavored the accurate identification of /n/, corroborating previous studies (Hazan et al., 2006, Kluge 2007) and supporting the second hypothesis of RQ 3. Just as for the results of /m/, the *A only* test condition disfavored the Brazilian listeners' identification of /n/ when compared not only to AV, but also to the *V only* test condition. For the American listeners, this difference was only found in the identification of the English word-final nasal /n/.

The results for both /m/ and /n/, thus, indicate that the Brazilian EFL learners seemed to benefit from AV presentation, as discussed by Grant and Seitz (1998b), in their identification of the word-final nasal consonant. This demonstrates the importance of visual input (with or without audio) for the perception of a visually distinctive contrast such as English word-final /m/ and /n/ by the Brazilian listeners.

This importance is in accordance with one of the strategies observed to be used by the Brazilian listeners to decide whether the word-final consonant was /m/ or /n/ in the Three-Condition Identification Test. During the tests with video input (*AV* and *V only*), the majority of the participants (30 out of 42) were observed by the researcher to be articulating, silently or not, both nasal consonants, apparently in order to perceive the difference between them and then decide which nasal consonant was /m/ and which was /n/. This was a demonstration that the visual input probably helped the participants to distinguish /m/ from /n/.

This analysis is also supported by the participants' impressions (assessed by means of a questionnaire as explained in 5.3.1) regarding the difficulty they felt in identifying both nasals in each of the three conditions. Most of the Brazilian listeners (36 out of 42) reported that the *AV* was the easiest test condition for the identification of the target nasal because, as they reported, they could see the movement of the lips/mouth which helped them to identify the consonant that they heard. They also reported that the video helped them to confirm or disconfirm the word-final nasal consonant they heard. Five participants indicated *V only* as the easiest conditions, and only one participant indicated the test condition *A only*.

As regards the most difficult condition, most participants (31 out of 42) reported the *A only* to be the most difficult one. One of the reasons reported was the fact that the words were not contextualized and they had no other source to help them to decide which nasal consonant they heard. Eleven participants indicated *V only* as the most difficult test condition because, as they reported, they are not used to paying attention only to the movement of the lips/mouth to identify the English word-final consonants /m/ and /n/. None of the participants selected the *AV* condition as the most difficult one.

When asked if they generally pay attention to the movements of the mouth/lips when talking to another person in either BP or English, twenty-three participants reported that they do in BP when in a noisy situation or when they want to pay better attention to what is been said, and thirty-two participants reported that they do when speaking English in face to face conversation when they do not understand a specific word or what is being said in general.

As explained in 5.3.3, there were six different orders of presentation of the three conditions: (a) *A only*, *AV*, *V only*; (b) *A only*, *V only*, *AV*; (c) *AV*, *V only*, *A only*; (d) *AV*, *A only*, *V only*; (e) *V only*, *A only*, *AV*; and (f) *V only*, *AV*, *A only*. Thus, seven participants performed the Three-condition Identification Test in each one of the six different orders of presentation. In order to investigate whether order of presentation might have affected the accurate identification of English word-final nasals, the Friedman statistical test was run and revealed that the differences were not statistically significant (X^2 (5, N = 7) = 3.663, p = .599). Thus, there was not an effect of order of presentation on the identification of /m/ and /n/ in the Three-condition Identification test by the Brazilian listeners.

Formal instruction on English sounds and pronunciation, and some kind of formal instruction on phonetic symbols were also considered possible variables that could affect the identification of /m/ and /n/ in word-final position in each of the three condition tested. As there was not an effect for word-final nasal consonant in this identification test, the results were analyzed combining both nasal consonants. Thus, the

Wilcoxon test was run and revealed that the difference in performance of the participants with and without formal instruction on English sounds and pronunciation was not significant in any of the test conditions: *A only* (Z = -1.186, p = .236), *AV* (Z = -.360, p = .719), and *V only* (Z = -1.296, p = .195). The Wilcoxon test also confirmed the differences were not significant in any of the test conditions for the performance of the participants with and without some kind of formal instructions on English phonetic symbols: *A only* (Z = -1.729, p = .084), *AV* (Z = -.792, p = .428), and *V only* (Z = -.806, p = .420). Thus, whatever formal instruction some of the participants may have had in phonetics and pronunciation apparently did not help them in their ability to identify the English final nasal consonants in any of the three conditions tested.

A comparison of the performance of the American and the Brazilian groups in the Three-condition Identification Test showed that, in general, the American listeners outperformed the Brazilian listeners in the identification of both word-final nasal consonants in each of the three conditions tested. Both groups, however, had a better performance in the conditions with video input (*AV* and *V only*). Thus, whether native speakers or not, it seems that listeners benefit not only from *AV* presentation, as discussed by Grant and Seitz (1998b), but also from *V only* presentation in the accurate identification of the English /m/ and /n/ in word-final position, as they have a visual distinctive contrast.

6.2.2.2 Results of Three-condition Identification Test by preceding vowel

The other research question related to this identification test was RQ 4 which aimed at investigating whether the height of the preceding vowel (high, medium or low) would influence the Brazilian listeners' identification of the word-final /m/ and /n/. The first hypothesis linked to this research questions stated that a high preceding vowel would disfavor the accurate identification of /m/ in the Three-condition Identification Test, and the second hypothesis stated that a low preceding vowel would favor the accurate identification of /n/. Table 31 displays the number of correct identifications of each of the nasal consonants in the context of three preceding vowels /ɪ/, /ɛ/ and /æ/ in each of the three test conditions. There were 336 responses for each of the preceding vowels for each of the target nasals in each of the three conditions, resulting in a total of 1008 responses for each consonant in each condition.

Table 31. Brazilian listeners' results of the identification of /m/ and /n/ by preceding vowel in the Three-condition Identification Test.

	/m/						/n/					
	A only		*AV*		*V only*		*A only*		*AV*		*V only*	
/ɪ/	263	(78.3)	312	(92.8)	319	(94.9)	303	(90.2)	333	(99.1)	329	(97.9)
/ɛ/	326	(97.0)	333	(99.1)	328	(97.6)	240	(71.4)	322	(96.8)	318	(94.6)
/æ/	303	(90.2)	331	(98.5)	327	(97.3)	305	(90.8)	335	(99.7)	327	(97.3)

Note: n = 336 for each consonant in each vowel context in each condition

Table 31 shows that, in general, the percentage of the accurate identification of /m/ increased by context from the high preceding vowel to the low vowel to the medium vowel in all of the three conditions tested. The Friedman test showed that the differences were significant for the *A only* (X^2 (2, N = 42) = 25.491, p = .000) and for the *AV* condition (X^2 (2, N = 42) = 22.327, p = .000), but not for the *V only* condition (X^2 (2, N = 42) = 3.561, p = .169). Wilcoxon *post hoc* tests yielded significance between all three pairs in the *A only* condition: /ɪ/ versus /ɛ/ (Z = -4.003, p = .000) and versus /æ/ (Z = -2.612, p = .009), and /ɛ/ versus /æ/ (Z = -3.414, p = .016). In the *AV* condition, the Wilcoxon yielded significance between /ɪ/ versus /ɛ/ (Z = -3.442, *p* = .001) and versus /æ/ (Z = -2.854, *p* = .004), but not between /ɛ/ versus /æ/ (Z = -.552, *p* = .581). Thus, the high preceding vowel disfavored the accurate identification of the word-final /m/ by the Brazilians in both the *A only* and *AV* conditions, but not in the *V only* condition. The vowel-context effect was stronger in the *A only* condition, where both the high and low vowels disfavored accurate identification of /m/. Thus, the results for /m/ partially support the first hypothesis of RQ 4, since the high preceding vowel disfavored the accurate identification of /m/ in only the *A only* and *AV*, indicating that this vowel effect is valid only for auditory perception.

As regards the effect of preceding vowel on the identification of /n/, Table 31 shows that, in general, the Brazilians obtained lower scores in the context of the preceding medium vowel /ɛ/ in all of the three conditions tested. Similar to the vowel effect for /m/, the Friedman tests yielded significant differences in the *A only* condition (X^2 (2, N = 42) = 18.673, *p* = .000) and in the *AV* condition (X^2 (2, N = 42) = 6.080, *p* = .048), but not in the *V only* condition (X^2 (2, N = 42) = 4.200, *p* = .122). The Wilcoxon *post hoc* tests showed this significance to be only between /ɛ/ versus /ɪ/ – yielding (Z = -3.719, *p* = .000) in the *A only* condition and (Z = -2.050, *p* = .040) in the *AV* condition – and between /ɛ/ versus /æ/ – yielding (Z = -3.529, *p* = .000) in the *A only* and (Z = -2.047, *p* = .041) in the *AV* condition. No significance was found for /ɪ/ versus /æ/ in the *A only* condition (Z = -.324, *p* = .746) or in the *AV* condition (Z = -816, *p* = .414). Thus, these results indicate that the medium preceding vowel disfavored the accurate identification of the word-final /n/ in the *A only* and *AV* condition by the Brazilian listeners of this study, and thus, lend only weak support to the second hypothesis of RQ 4 and do not totally corroborate Kluge (2007), as the low preceding vowel favored accurate identification of the /n/ only compared to the mid vowel and not compared to the high vowel. Similar to the results concerning the bilabial consonant, these results indicate the vowel effect found refers only to auditory perception.

Comparing the Brazilian and the American groups in relation to effect of preceding vowel in the Three-condition Identification test, the effects found for the Brazilian listeners the *A only* and *AV* test conditions were not found for the American listeners in any condition. Thus, this effect appears to be relevant only for non-native listeners.

6.3 Summary and further discussion of the results

In this chapter, the results of the performance of the control group and the Brazilian group were reported and analyzed concerning the identification of English word-final nasals /m/ and n/ in each of the two identification tests designed for the present research: the N-like versus NN-like Identification Test and the Three-condition Identification Test. The overall results for the N-like versus NN-like test indicate that the accurate identification of the N-like realization of the word-final nasal consonants was difficult for both the Brazilian and the American listeners. Whereas Kluge (2004), using the same instrument, found the identification of the N-like realization easier for a group of three American listeners than for a group of twenty Brazilian pre-intermediate learners of English, this study found no statistically significant difference between the American and Brazilian groups. This difference between the findings of the two studies may be due to two differences: (a) the intermediate Brazilian listeners of this outperformed the pre-intermediate participants in Kluge (2004), thus indicating a possible influence of the participants' proficiency; (b) the American listeners of the previous study, who had lived in Brazil from three months to two years, outperformed those of the present study, who had never been exposed to BP and had little knowledge of any other foreign language, thus implying an effect of language contact

The presence or absence of contrast was apparently important for both groups of this study, in support of Hypothesis 2. The *different* trials favored the accurate identification of both N-like nasal consonants for the Brazilians and only of /n/ for the Americans, however, there was a non-significant tendency in the same direction for /m/ by the Americans. Thus, in general, the Brazilian and the American listeners of this study were better able to identify the N-like realization of English word-final nasals /m/ and /n/ when presented in contrast to the NN-like realization, corroborating (Kluge 2004, 2007).

In the analysis of type of trial, the lowest scores were obtained by both the Brazilian and the American listeners in those trials where the response should have been *neither*. Thus, results indicate that it was difficult for all participants to perceive that both realizations were NN-like (*neither*) pronunciations. In general, when the participants heard two NN-like pronunciations, they either responded correctly or responded 1 or 2; they rarely responded *both* when it was *neither*. This may indicate that when the participants noted a slight difference in one of the two realizations within the trial, they tended to choose one as more N-like than the other, which may be a result of their expectations.

For both the American and the Brazilian listeners, a talker effect was found, although for the Americans the effect was stronger. Results for *different* trials indicated that the American listeners tended to favor any type of realization, N-like or NN-like, produced by the N talker. However, the Brazilian listeners tended to favor the N talker realization for the identification of only /n/.

Results for *same* trials, indicated that the American listeners tended favor the N talker realization of /m/ and /n/ than the Brazilian listeners. In general, the American listeners tended to choose only the N talker realization as the correct one rather than identifying both realizations as either N-like (*both*) or NN-like ones (*neither*), whereas the Brazilian listeners identify both realizations of /m/ and /n/ as either N or NN-like ones. The only condition in which the Americans and the Brazilians had the same influence of the N talker realization was in the identification of both realizations of word-final /n/ as NN ones (*neither*). To sum up, these results for the effect of N talker realization seemed to indicate that while the American listeners may have relied on different perceptual cues, and not only on the absence or presence of the complete realization of the word-final nasal consonants to decide whether the realization was N-like or not; the Brazilians may have only focused on the realization of the word-final nasal consonants

As for the effect of preceding vowel in the N-like vs. NN-like Identification Test the accurate identification of the N-like realization of both /m/ and /n/ by the Brazilian listeners increased from the high vowel to the mid vowel to the low vowel, corroborating Kluge (2004). The results found for the American listeners were also in the direction of those of previous studies, but not significant.

As regards Three-condition Identification Test, test condition was found to affect the accurate identification of word-final /m/ and /n/ for the Brazilians, and of /n/ for the

Americans. The *A only* condition disfavored the accurate identification of /m/ and /n/ compared not only to the *AV* condition, corroborating previous studies (Hazan et al, 2006, Kluge, 2007); but also compared to the *V only* condition. These results indicate that visual cues favor the accurate identification of visual distinctive contrasts such as English word-final nasals /m/ and /n/. As discussed in the analysis, observations during data collection with the Brazilian listeners lent support to this conclusion. In fact, BP speakers do not have difficulty in articulating /m/ or /n/ as they distinctively realize these nasal consonants in word-initial position (e.g., *meta* – 'goal' *neta* – 'granddaughter'). This suggests that the Brazilian learners may be able to transfer the word-initial distinction present in BP to the word-final distinction in English by observing the visual cues present in the production of these nasal consonants by native speakers.

As for the effect of the vowel preceding the English nasal consonants, results revealed no effect for the American listeners in the identification either /m/ or /n/ in any of the conditions of the Three-condition Identification Test. On the other hand, there was an effect for preceding vowel in the identification of /m/ and /n/ only in the *A only* and *AV* conditions for the Brazilian listeners. Whereas the mid preceding vowel favored the accurate identification of /m/, the high preceding vowel disfavored it These results for the high preceding vowel are in conformance to those of previous studies (Kurowski & Blumstein, 1987, 1995, Kluge, 2007). As for word-final /n/, the mid preceding vowel disfavored the accurate identification of this nasal consonant by the Brazilians. These results are contrary to those of Kluge (2007), who found the low preceding vowel to favor the accurate identification of /n/ in the Three-condition Identification Test.

This study also considered other possible variables that could affect the identification of /m/ and /n/ such as order of presentation, formal instruction on English sounds, pronunciation, and phonetic symbols in the Three-condition Identification test, and gender in both identification tests. None of these were found to have an effect, except for gender in the Three-condition test for the identification of /m/ by the Brazilian listeners in the *V only* condition, where the women were shown to have a slight advantage.

In general, the results showed that English word-final /m/ tended to be more accurately identified than /n/ in both tests for both groups. To the best of my knowledge, there is no explicit explanation to this finding. As reviewed in Chapter 2, previous studies that examine the differences between the two English nasals with native listeners have focused more on their acoustic characteristics as regards murmur and formant transitions (Malécot, 1956; Nakata, 1959; Nord, 1976 all cited in Kurowski & Blumstein, 1995; Kurowski & Blumstein, 1984, 1995; Repp, 1986; Ohde et al., 2006). As discussed in 3.2, one aspect in common among some of these and other studies (Kurowski & Blumstein, 1984; Repp, 1986; Sharf & Ostreicher, 1973; Zee, 1981 cited in Kurowski & Blumstein, 1995) was the finding that /m/ and /n/ were easier to identify in certain vowel contexts, but none of them claimed that one of these two nasals was easier or more difficult to perceive than the other except Recasens (1988), who claims that /m/ is more distinctive than /n/ with respect to the other nasals, but does not give an explanation. A tentative explanation could be that the farther back the closure of the nasal consonant, the more likely it is to be perceptually similar to the sound of the lowering of the velum occurring in the production of a nasal or nasalized vowel. Thus, in this study, the alveolar /n/ would be more easily confused with a nasal vowel, and if the velar nasal /ŋ/ had been included in the study, it is likely that it would have been even more difficult to distinguish from a nasalized vowel. In addition, as Recasens (1988) points out, "large coarticulatory effects in tongue body activity during the production of the bilabial [m] may have limited perceptual consequences because of lip closure" (p. 235), different from /n/, which is more sensitive to coarticulatory effects.

To conclude this chapter, the findings of this study can be examined from the perspective of the models of speech perception discussed in Chapter 4 – the SLM and the NLM. The general results of both groups in the N-like vs. NN-like Identification Test were unexpected low, particularly those of the American listeners. Due to the PB word-final /m/ and /n/ phonetic categories, as treated by the SLM, or their prototypes, as referred to by the NLM, it could be expected that the Brazilian listeners would have more difficultly perceiving the English target nasals than the American listeners, which did not occur. These phonetic categories would either have to be at the "position-sensitive allophonic level" posited by Flege (1995, p. 239) or they would have to be units the size of the syllable or rhyme, as posited by Baptista (2004)[3].

It is important to keep in mind that the Brazilian listeners may not necessarily have perceived the native-like speech as well as the Americans in all aspects. They may have perceived a specific aspect of the native-like speech as well as the Americans: the presence of fully realized word-final nasal consonants preceded by an oral vowel. In fact, the they may have perceived this aspect better than the Americans because they

[3] Baptista (2004) proposed an extension to Flege´s model which would "include, among the phonetic categories to be learned/acquired, units larger than the segment, such as the syllable, onset, or coda." (p. 475)

have some degree of knowledge of both languages, and possibly phonetic categories of the syllables ending in nasals in both languages, however imprecise one of them one of them may be. On the other hand, their phonetic categories are probably missing the other characteristics included in the phonetic categories of the American listeners, such as those mentioned in 6.2.1.2.3 as allowing the holistic perception, which may have compensated for the American listeners lack of knowledge of BP..

Brazilians' L2 proficiency is another factor that should also be taken into account for explaining why the control and the experimental groups performed similarly, although both obtained low scores. The intermediate EFL learners from the present study performed better than the pre-intermediate learners from Kluge (2004), which may indicate that some of the current participants have constructed phonetic categories that enabled them to perceive the relevant differences between the L1 and L2 phonetic realizations of word-final /m/ and /n/, which would make their performance closer to that of the American listeners. To sum up, studies with listeners proficient in both languages are needed in order to further investigate the claims made here.

Chapter 7

Conclusion

7.1 Major findings

The main objective of this study was to investigate perception of the English word-final nasals /m/ and /n/ by Brazilian EFL learners in two perception tests: the N-like vs. NN-like Identification Test contrasting N-like and NN-like realization of those nasal consonants, and the Three-condition Identification Test contrasting presence and absence of visual cues on the identification of the word-final nasal consonants. This study also investigated the effect of preceding vowel in the identification of word-final /m/ and /n/ in both perception tests, as the literature has shown that phonological context does affect the perception of the target nasals (Sharf & Ostreicher, 1973; Kurowski & Blumstein, 1984; Repp, 1996; Zee, 1981, cited in Kurowski & Blumstein, 1995, p. 199; Kluge, 2004, 2007). The results of this study confirmed some of the specific hypotheses regarding these tests presented in the Method.

As regards the hypothesis of RQ 1, according to which the Brazilian learners would be better able to identify the N-like realization of the English word-final nasals when presented in contrast, the results showed that it was confirmed. As a matter of fact, results showed that, in general, not only the Brazilian learners, but also the American listeners were better able to identify the N-like realization of English word-final nasals /m/ and /n/ when they were presented in *different* trials, i.e., in contrast, corroborating previous studies (Kluge, 2004, 2007). The results related to this research question also revealed that the Brazilian and the American listeners obtained the lowest scores when they had to identify that both realizations were NN-like (*neither*) pronunciations of the word-final nasal consonants.

The participants' responses were also analyzed according to talker in the identification of the N-like realization of the word-final nasals /m/ and /n/ in *different* and *same* trials. Results for the American listeners showed that they tended to favored the realization produced by the N talker for both nasal consonants in either the *different* and the *same* trials, whereas the Brazilians showed the same pattern only for /n/ in the *neither* trials.

As to the hypothesis of the RQ 2, according to which low preceding vowel would favor and high preceding vowel would disfavor the accurate perception of /m/ and /n/ in word-final position in the N-like vs. NN-like Identification Test, the results showed that it was confirmed. These results for the Brazilian participants supported those of previous study (Kluge, 2004) as predicted. The results for the American listeners were also in the direction of those of previous studies, although, statistical tests showed they were not statistically significant.

The first hypothesis of RQ 3, which predicted that the *AV* condition would favor/facilitate the accurate identification of both English word-final nasals, was confirmed. In fact, results showed that the Brazilian participants obtained higher scores in two conditions with video input (*AV* and *V only*) indicating that visual cues seemed to favor the accurate identification of English word-final nasals /m/ and /n/ not only in *AV* condition, as predicted, but also in the *V only* condition. The same tendency was found for the American listeners.

The second hypothesis of RQ 3, which predicted that the *A only* condition would disfavor the accurate identification of /m/ and /n/ in word-final position when compared to the *AV* condition, was confirmed. As a matter of fact, results revealed that the *A only* condition disfavored the accurate identification of both word-final nasals when compared not only to *AV*, supporting the previous study (Kluge, 2004); but also when compared to *V only* condition. The same tendency was found for the American listeners but only in the identification of word-final /n/.

As to the first hypothesis of the RQ 4, which predicted that the high preceding vowel would disfavor the accurate perception of /m/ in word-final position in the Three-condition Identification Test, was partially confirmed. Results revealed that the high preceding vowel disfavored the Brazilian participants' identification of the bilabial nasal consonant only in two of test conditions (*A only* and *AV*). Results also showed that the medium preceding vowel favored the accurate identification of /m/ in those two test conditions. Results showed no effect for preceding vowel in the *V only* condition by the Brazilian participants. As for the American listeners, there was not an effect for preceding vowel in the identification of /m/ in any of the three conditions tested.

The second hypothesis of RQ 4, which predicted that low preceding vowel would favor the accurate perception of /n/ in word-final position in the Three-condition Identification Test, was partially confirmed, as the low preceding vowel favored the identification of /n/ only compared to the mid vowel. Results for the Brazilian participants revealed that, differently from Kluge (2007), the preceding vowel that significantly disfavored the accurate identification of this nasal consonant in the *A only* and *AV* condition was the medium vowel. Results also revealed no effect for preceding vowel in the *V only* condition by the Brazilians. As regards the American listeners, there was not an effect for preceding vowel in the identification of /n/ in any of the three test conditions. Results showed that preceding vowel affected the accurate identification of the nasals only in the conditions that involved auditory stimuli (*A only* and *AV)*. A summary of the results per hypothesis is displayed in Table 27.

Table 32. Summary of the results per hypothesis (H).

Hypotheses	Results
H1. The Brazilian learners will be better able to perceive the distinction between N-like versus NN-like realization of English word-final nasals when they are presented in contrast.	Confirmed.
H2. Low preceding vowel will favor and high preceding vowel will disfavor the accurate perception of /m/ and /n/ in word-final position in the N-like vs. NN-like Identification Test.	Confirmed.
H3.1. The *AV* condition will favor/facilitate the accurate identification of both word-final nasals.	Confirmed.
H3.2. The *A-only* condition will disfavor the accurate identification of both word-final nasals when compared to the *AV* condition.	Confirmed.
H4.1. High preceding vowel will disfavor the accurate perception of /m/ in word-final position in the Three-condition Identification Test.	Partially confirmed.
H4.2. Low preceding vowel will favor the accurate perception of /n/ in word-final position in the Three-condition Identification Test.	Partially confirmed.

Summarizing the overall results of the Three-condition Identification Test, the *A only* condition, compared to the *AV* and *V only* conditions, disfavored the accurate identification by the Brazilian listeners of both /m/ and /n/, there being no effect for place of articulation of the nasal consonant, but of only /n/ by the American listeners, for whom there was a nasal consonant effect. These results not only support the second hypothesis of RQ 3, which stated that the *A only* condition would disfavor the accurate identification by the Brazilian listeners of both English word-final nasals compared to the AV condition, but they also show that the visual input is so important that this was also true in comparison to the *V only* condition. In other words, it was actually easier for the Brazilian listeners to identify the place of articulation of the word-final nasal consonants visually than auditorily. This result may have extremely important implications for the classroom.

7. 2 Pedagogical Implications

Studies considering Brazilian English interphonology are very important to contribute to the improvement of pronunciation teaching and the development of pronunciation materials concerning the BP speakers' specific difficulties concerning English learning. The findings of the present study lead to some pedagogical implications, as they indicated the Brazilians speakers' difficulties regarding perception of English word-final the nasals /m/ and /n/. Thus, if language teachers become aware of which variables may favor/disfavor the accurate identification of those nasal consonants, they can help their learners to improve their L2 perception.

Results showed that Brazilian learners were better able to identify the N-like realizations of word-final nasals /m/ and /n/ when they were present in contrast to a NN-like realization. Thus, English teachers could first present those realizations in contrast (N-like vs. NN-like) in order to call students attention to the differences so that, later, they may be able to identify when two or more realizations are either N-like or NN-like. One example of how L1 and L2 differences can be highlighted is given by Baptista's (1988b) pronunciation manual, which proposes the imitation of American accent in Portuguese, so that the EFL learners' attention is drawn to the peculiarities of the L1 and L2 contrasts. With reference to the word-final nasal consonants, students could imitate, for instance, the American pronunciation of Portuguese words such *bom* – 'good', and *pólen* – 'pollen'.

Results also showed that, in general, Brazilians listeners had less talker effect in identifying N-like realizations than American listeners. As a matter of fact, in some of the results Brazilians identified NN-like realizations better than N-like ones. Usually, Brazilian learners are more exposed to NN talker realizations, as, in the classroom, they are usually more exposed to the pronunciation of Brazilian teachers of English. Following the reasoning of the speech perception models reviewed in this study (SLM and NLM), if accurate perception precedes accurate production, the learners should be more exposed to native speech so that they might, eventually, produce the target nasals accurately.

The results of the Three-condition Identification Test showed that the Brazilian learners of English seemed to profit from visual input, either with or without audio, when compared to audio only input. Therefore, language teachers should consider increasing the use of visual input in their classes such as drawing students' attention to the movement of the lips and mouth while pronouncing visually distinctive contrasts such as English word-final /m/ and /n/. This can be done either by the teacher as he/she is talking to the students, or by showing videos with N-like pronunciations of those English word-final sounds.

By noticing the movement of the lips/mouth while hearing/seeing the realization of the English word-final nasal /m/ and /n/, Brazilian learners may became aware of the difference in the realization of those final nasals in English and BP and may transfer this knowledge to the pronunciation of those sounds, as the BP speakers do not have any difficulty in articulating either /m/ or /n/, since they produce them distinctively in word-initial position in BP (e.g., *meta* – 'goal' *neta* – 'granddaughter'). Therefore, teachers play an important role in this process, as they may call students´ attention to the differences in the pronunciation of specific L1 and L2 sounds in different word positions.

Taking into consideration the benefits of *AV* and *V only* presentations found in this study, materials developers should consider not only audio input for listening practices, but also video input to improve the identification of visually distinctive contrast such as the English word-final nasal consonants of the Brazilian learners. The use of materials with audio and video could help the Brazilian learners of English to improve not only the perception of English visually distinctive contrast, but also the production of those contrasts.

Finally, as regards phonological context, general results showed that preceding vowel seemed to affect the accurate identification of both English nasal consonants in word-final position the N-like vs. NN-like Identification Test as the low preceding vowel favors and the high preceding vowel disfavored the accurate perception of those nasal consonants. However, results also showed different tendencies for word-final /m/ and /n/ in different conditions. While the high preceding vowel disfavored and the medium preceding vowel favored the accurate identification of word-final /m/ in the *A only* and *AV* conditions, the medium vowel disfavored the accurate identification of word-final /n/ in the *A only* and *AV* conditions. Thus, if English teachers become aware of which preceding vowels may favor/disfavor the accurate identification of each of the English target nasals of this study, they can help their learners to improve their identification by presenting and practicing those consonants in the context of each preceding vowel in different conditions such as *A only, AV, V only* and N versus NN-like realizations, for instance.

7.3 Limitations and suggestions for further research

The several limitations of the present research will be left as suggestions for future research. As regards the N-like vs. NN-like Identification Test, results indicated that the N-like stimuli recorded by the NN talker may have influenced the perception of the control group (American listeners) as it seems that she could not keep the same quality of the preceding vowel in the NN-like realization as the N talker could. Thus, in order to minimize such talker effect, further research could have just one N talker of English proficient in BP and phonetically trained who could maintain the English vowel quality even when nasalized.

The American listeners of this study reported that they had never been exposed to BP. Thus, further research could investigate whether exposure to BP influences the identification of the N-like realization of word-final nasal consonants by comparing the performance of two control groups: with and without exposure to BP

As regards the Three-condition Identifications Test, there were few participants in each of the six different orders of presentation. Thus, in order to further investigate whether order of presentation influenced the identification of word-final nasals in this test, further research should have more participants in each order of presentation.

In order to better investigate if there is an effect for formal instruction on English sounds and pronunciation and some kind of formal instruction on phonetic symbols in the Three-condition Identification Test there should be the same number of participants in each group, or the formal instruction could be carried out with half of the group as part of the research.

The stimuli of the Three-condition Identification Test were recorded by only a male N talker. Further research could also have a female N talker in order to investigate whether there is or not an effect for gender in the identification of the stimuli provided to the participants.

Regarding preceding vowel, the present study only investigated the identification of word-final nasals in the context of three preceding vowels in both perception tests. Thus, further research could investigate the identification of those consonants in the context of other preceding vowels.

Another variable that was not addressed in this study and could be investigated is the effect of training in the identification of English word-final nasals /m/ or /n/. Further research could investigate whether training with video input (*AV* and *V only* conditions) could improve the identification of visually distinctive contrasts in Audio only condition. Besides, as this piece of research only investigated the perception of English word-final nasal consonants, further research could also investigate the production, as well as the relationship between those skills by the Brazilian EFL learners.

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APPENDIXES

APPENDIX A

Free Speech Rating

Free Speech Rating: Rate the accent of each speech from **1 to 5,** 1being non-native-like and 5 close to native-like.

1.

1	2	3	4	5

2.

1	2	3	4	5

3.

1	2	3	4	5

4.

1	2	3	4	5

5.

1	2	3	4	5

6.

1	2	3	4	5

7.

1	2	3	4	5

8.

1	2	3	4	5

9.

1	2	3	4	5

10.

1	2	3	4	5

11.

1	2	3	4	5

12.

1	2	3	4	5

13.

1	2	3	4	5

14.

1	2	3	4	5

APPENDIX B

Background Questionnaire – Portuguese Version

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literatura Correspondentes
Doutoranda: Denise Cristina Kluge
Orientadora: Prof. Dra. Bárbara Oughton Baptista

Questionário sobre os participantes da pesquisa:
Por favor, responda às perguntas abaixo. Este questionário objetiva obter somente informações que serão utilizadas para auxiliar a análise de dados da presente pesquisa conduzida pela doutoranda acima citada. Em nenhuma hipótese os nomes dos participantes serão divulgados, pois esta é uma pesquisa quantitativa.
Email: ________________________________Fone:____________________________
1. Nome: ____2. Data__________
3. Idade: _____________________ 4. Sexo: FEM / MASC
5. Tem algum problema de audição? (SIM / NÃO)

Responda às perguntas abaixo procurando ser o mais especifico possível sobre os eu contato com a língua inglesa.

6. Que curso de inglês está cursando atualmente? _____________________________

7. Qual nível/fase você está? ____

8. Fez curso de inglês além do curso atual? SIM / NÃO

9. Por quanto tempo? ____

10. As aulas exploravam comunicação **escrita** (SIM/ NÃO) e **oral** (SIM / NÃO)?

11. Quantos anos você estudou inglês, considerando cursos, ensino médio, fundamental, etc.? ____

12. Quantas horas por semana, além do curso que está fazendo atualmente, você se dedica ao estudo da língua inglesa?
____

13. Tem vivência em país de língua inglesa? SIM / NÃO

14. Por quanto tempo?
____

15. Quantos anos você tinha na época?
____

16. Conversa em inglês com outros brasileiros? SIM / NÃO

17. Com que freqüência? _____________________

18. Conversa em inglês com falantes nativos? SIM / NÃO

19. Quantas vezes por semana? _____________________

20. Assiste a filmes com som original (sem dublagem)? SIM / NÃO

21. Quantas vezes por semana? _____________________

22. Conversa em "chats"/grupos de bate-papo em inglês na internet? SIM / NÃO

23. Quantas vezes por semana? _____________________

24. Ouve música em inglês? SIM / NÃO

25. Quantas vezes por semana? _____________________

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

27. Já teve aulas especifícas sobre sons e/ou pronúncia do inglês (SIM / NÃO) e sobre símbolos fonéticos (SIM / NÃO)?

28. Por quanto tempo? ______________________

29. Estuda/estudou ou tem contato com outra língua estrangeira além do inglês? SIM/ NÃO

30. Qual língua?
____

31. Em que cidade foi criado/a?
____

32. Qual sotaque você considera ter no português? (por exemplo: norte/sul do país, do estado)
____

33. Quando fala em inglês, qual sotaque você considera ter (americano, britânico, australiano, etc)?
____

34. Adicione qualquer informação que considere interessante em relação ao seu contato com a língua inglesa.
____

Eu entendo que participar desta pesquisa é de minha inteira responsabilidade, que os dados informados são reais e que não serão individualmente revelados. Eu aceito participar desta pesquisa.

____

Assinatura

APPENDIX C

Background Questionnaire – English Version

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literatura Correspondentes
Researcher: Denise Cristina Kluge
Adviser: Prof[a] Dr[a]. Bárbara Oughton Baptista

Questionnaire about research participants:
Please, answer the questions below.
This questionnaire aims only at getting information to help in the analysis of the data of the present study. The names of the participants will not be revealed, as this is a quantitative research.
E-mail:___________________________ Phone:_________________________________
1. Name: ____ 2. Date: __________
3. Age: ______________________ 4. Gender: Female / Male
5. Do you have any hearing problem? (YES / NO)

Answer the questions below about your contact with English, being as specific as possible.

6. Which English course are you taken? __________________________________

7. Which level are you attending? ____

8. Have you taken other language courses besides the Extracurricular? YES / NO

9. For how long? ____

10. Did the classes develop **written** (YES / NO) and **oral expression** (YES / NO)?

11. How many years have you studied English, considering English courses and regular school English classes? ____

12. How many hours a week, besides the course hours, do you dedicate to English study?____

13. Have you lived in an English speaking country? YES / NO

14. For how long? ____

15. How old were you at that time? ____

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

17. How often? ________________

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

19. How often? ________________

20. Do you watch movies without dubbing? YES / NO

21. How often? ________________

22. Do you chat in English on the internet? YES / NO

23. How often? ____________________

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

25. How often? ________________

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

27. Have you ever had specific classes on English sounds and pronunciation (YES / NO) and/or phonetic symbols (YES / NO)?

28. For how long? ______________________

29. Do you study/have you studied/do you have contact with any other foreign language besides English? YES / NO

30. What language? ____

31. Where did you grow up? ____

32. What is your regional accent in Portuguese?
____

33. When speaking English, which accent do you think you have (American, British, Australian, etc.)? ____

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

I understand that participating in this research project is entirely of my responsibility, the data informed above are real, and I acknowledge that the answers will not be individually revealed. I accept taking part of the study.

____

Signature

APPENDIX D

Questionnaire – Portuguese Version

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literatura Correspondentes
Aluna: Denise Cristina Kluge
Orientadora: Prof. Dra. Bárbara Oughton Baptista
Questionário sobre o Teste de Percepção com Pistas Visuais

Participante: ____

Por favor, responda às perguntas abaixo procurando ser o mais especifico possível sobre o teste de percepção que você acabou de fazer. Este questionário objetiva obter somente informações que serão utilizadas para auxiliar a análise de dados da presente pesquisa. Em nenhuma hipótese os nomes dos participantes serão divulgados, pois esta é uma pesquisa quantitativa.

Parte de Áudio

1. Identificar a consoante final somente com áudio foi:
( ) muito fácil ( ) fácil ( ) razoável ( ) difícil ( ) muito difícil

2. Por quê? ____

3. Você já tinha feito um teste de percepção semelhante? ( )Sim ( ) Não

4. Em relação à duração desta parte do teste, você achou:
( ) curta ( ) boa ( ) longa ( )muito longa

5. Ainda em relação à duração, você achou esta parte do teste:
( ) cansativa ( ) muito cansativa ( ) não achei cansativa

Parte de Áudio e Vídeo

6. Identificar a consoante final com áudio e vídeo foi:
( ) muito fácil ( ) fácil ( ) razoável ( ) difícil ( ) muito difícil

7. Por quê? ____

8. Você já tinha feito um teste de percepção semelhante? ( )Sim ( ) Não

9. Em relação à duração desta parte do teste, você achou:
( ) curta ( ) boa ( ) longa ( )muito longa

10. Ainda em relação à duração, você achou esta parte do teste:
( ) cansativa ( ) muito cansativa ( ) não achei cansativa

Parte de Vídeo

11. Identificar a consoante final somente com vídeo (sem som) foi:
( ) muito fácil ( ) fácil ( ) razoável ( ) difícil ( ) muito difícil
12. Por quê? ____

13. Você já tinha feito um teste de percepção semelhante? ( )Sim ( ) Não

14. Em relação à duração desta parte do teste, você achou:
( ) curta ( ) boa ( ) longa ( )muito longa

15. Ainda em relação à duração, você achou esta parte do teste:
( ) cansativa ( ) muito cansativa ( ) não achei cansativa

Perguntas Gerais Teste de Percepção (incluindo as 3 Partes)

16. Em qual parte do teste você achou **mais fácil** identificar a consoante final?
( ) Parte de áudio ( ) Parte de áudio e vídeo ( ) Parte de vídeo

17. Por quê? ____
____

18. Em qual parte do teste você achou **mais difícil** identificar a consoante final?
( ) Parte de áudio ( ) Parte de áudio e vídeo ( ) Parte de vídeo

19. Por quê? ____
____

20. Você achou a duração do teste (incluindo as três partes)
( ) curta ( ) boa ( ) longa ( ) muito longa

21. Ainda em relação à duração, você achou o teste (incluindo as três partes)

( ) cansativo ( ) muito cansativo ( ) não achei cansativo

22. Quando você está falando com outra pessoa/pessoas **em português**, você presta atenção aos movimentos que a pessoa está fazendo com a boca enquanto fala?
( ) Sim ( ) Não

23. Em que situação/situações: ____
____

24. E quando você está falando com outra pessoa/pessoas **em inglês**, você presta atenção aos movimentos que a pessoa está fazendo com a boca enquanto fala?
( ) Sim ( ) Não

25. Em que situação/situações: ____
____

26. Sugestões/Comentários: ____
____

APPENDIX E

Questionnaire – English Version

Universidade Federal de Santa Catarina
Curso de Pós-Graduação em Inglês e Literatura Correspondentes
Researcher: Denise Cristina Kluge
Adviser: Prof[a] Dr[a]. Bárbara Oughton Baptista

Questionnaire about the Perception Test
Participant: ____
Please, answer the questions below being as specific as possible about the perception test you have just done. This questionnaire aims only at getting information to help in the analysis of the data of the present study. The names of the participants will not be revealed, as this is a quantitative research.

Audio Only
1. Identifying the final consonant only hearing the word was:
( ) very easy ( ) easy ( ) OK ( ) difficult ( ) very difficult

2. Why? ____

3. Have you taken a similar test before? ( )Yes ( ) No

4. As regards duration of this part of the test, you thought it was
( ) short ( ) OK ( ) long ( )very long

5. Regarding duration of this part of the test, you thought it was:
( ) tiresome ( ) very tiresome ( ) not tiresome

Audio and Video
6. Identifying the final consonant hearing and seeing the word was:
( ) very easy ( ) easy ( ) OK ( ) difficult ( ) very difficult

7. Why? ____

8. Have you taken a similar test before? ( )Yes ( ) No

9. As regards duration of this part of the test, you thought it was
( ) short ( ) OK ( ) long ( )very long

10. Regarding duration of this part of the test, you thought it was:
( ) tiresome ( ) very tiresome ( ) not tiresome

Video Only

11. Identifying the final consonant only seeing the video was:
( ) very easy ( ) easy ( ) OK ( ) difficult ( ) very difficult

12. Why? ____

13. Have you taken a similar test before? ( )Yes ( ) No

14. As regards duration of this part of the test, you thought it was
( ) short ( ) OK ( ) long ( )very long

15. Regarding duration of this part of the test, you thought it was:
( ) tiresome ( ) very tiresome ( ) not tiresome

General Questions about the Perception Test (including the 3 Conditions)

16. In your opinion, which condition was **the easiest** one to identify the final consonant?
( ) Only Audio ( ) Audio and Video ( ) Only Video

17. Why? ____
____

18. In your opinion, which condition was **the most difficult** one to identify the final consonant?
( ) Only Audio ( ) Audio and Video ( ) Only Video

19. Why? ____
____

20. As regards duration of the whole test (including the three conditions), you thought it was
( ) short ( ) OK ( ) long ( )very long

21. As regards duration of the whole test (including the three conditions), you thought it was
( ) tiresome ( ) very tiresome ( ) not tiresome

22. When you are speaking with another person **in Portuguese**, do you pay attention to the movement of his/her lips/mouth while he/she is speaking?
( ) Yes ( ) No

23. In what situations: ____
____

24. When you are speaking with another person **in English**, do you pay attention to the movement of his/her lips/mouth while he/she is speaking?
( ) Yes ( ) No

25. In what situations: ____
____

26. Suggestions/Comments:
____
____

APPENDIX F

Biographic Questionnaire

Questionnaire

Name:
____

e-mail____

Date:________________/2008

1. Age _________ 2. Gender: ( ) male ( ) female

3. Where are you from (city/State)?
____

4. Do you have any hearing problem or difficulty?
( ) no
( ) yes

5. Do you speak another foreign language frequently?
( ) no ( ) yes Which one?____

6. In the last 365 days, have you been to a country where English is not the main spoken language?
( ) no ( ) yes 7. Where? _____________________________________

8. What is the language there? ____

9. How long did you spend there? ______________________________________

10. When did you come back? ____

11. Did you learn this language? ( ) no ( ) yes

12. Are you still speaking or listening to this language or any other foreign language?
( ) no ( ) yes ____

I understand that participating in this research project is entirely of my responsibility, the data informed above are real, and I acknowledge that the answers will not be individually revealed. I accept taking part in the study.

____

Signature

APPENDIX G

Native-like vs. non-native-like Identification Test

* "same" trials
<u>underlined</u> – correct answer of the different trials

AE = spoken by the native speaker of American English
BP = spoken by the native speaker of Brazilian Portuguese

The oral instructions before all tests were given in BP for the Brazilian participants and in English for the American participants.

Tim Tim* [tɪm] AE [tɪm] BP
Tim Tim* [tɪm] BP [tɪm] AE
Tim Tim* [tɪ̃] AE [tɪ̃] BP
Tim Tim* [tɪ̃] BP [tɪ̃] AE
<u>Tim</u> Tim [tɪm] AE [tɪ̃] BP
<u>Tim</u> Tim [tɪm] BP [tɪ̃] AE
Tim <u>Tim</u> [tɪ̃] AE [tɪm] BP
Tim <u>Tim</u> [tɪ̃] BP [tɪm] AE
tin tin* [tɪn] AE [tɪn] BP
tin tin* [tɪn] BP [tɪn] AE
tin tin* [tɪ̃] AE [tɪ̃] BP
tin tin* [tɪ̃] BP [tɪ̃] AE
<u>tin</u> tin [tɪn] AE [tɪ̃] BP
<u>tin</u> tin [tɪn] BP [tɪ̃] AE
tin <u>tin</u> [tɪ̃] AE [tɪn] BP
tin <u>tin</u> [tɪ̃] BP [tɪn] AE
gem gem* [dʒɛm] AE [dʒɛm] BP
gem gem* [dʒɛm] BP [dʒɛm] AE
gem gem* [dʒɛ̃] AE [dʒɛ̃] BP
gem gem* [dʒɛ̃] BP [dʒɛ̃] AE
<u>gem</u> gem [dʒɛm] AE [dʒɛ̃] BP
<u>gem</u> gem [dʒɛm] BP [dʒɛ̃] AE
gem <u>gem</u> [dʒɛ̃] AE [dʒɛm] BP
gem <u>gem</u> [dʒɛ̃] BP [dʒɛm] AE

gen gen* [dʒɛn] AE [dʒɛn] BP
gen gen* [dʒɛn] BP [dʒɛn] AE
gen gen* [dʒɛ̃] AE [dʒɛ̃] BP
gen gen* [dʒɛ̃] BP [dʒɛ̃] AE
<u>gen</u> gen [dʒɛn] AE [dʒɛ̃] BP
<u>gen</u> gen [dʒɛn] BP [dʒɛ̃] AE
gen <u>gen</u> [dʒɛ̃] AE [dʒɛn] BP
gen <u>gen</u> [dʒɛ̃] BP [dʒɛn] AE
cam cam* [kæm] AE [kæm] BP
cam cam* [kæm] BP [kæm] AE
cam cam* [kæ̃] AE [kæ̃] BP
cam cam* [kæ̃] BP [kæ̃] AE
<u>cam</u> cam [kæm] AE [kæ̃] BP
<u>cam</u> cam [kæm] BP [kæ̃] AE
cam <u>cam</u> [kæ̃] AE [kæm] BP
cam <u>cam</u> [kæ̃] BP [kæm] AE
can can* [kæ̃] AE [kæ̃] BP
can can* [kæ̃] BP [kæ̃] AE
can can* [kæn] AE [kæn] BP
can can* [kæn] BP [kæn] AE
<u>can</u> can [kæn] AE [kæ̃] BP
<u>can</u> can [kæn] BP [kæ̃] AE
can <u>can</u> [kæ̃] AE [kæn] BP
can <u>can</u> [kæ̃] BP [kæn] AE

APPENDIX H- Familiarization Task

Native-like vs. non-native-like Identification Test

* “Same” trials
Underlined – correct answer of the different trials

bill	bill*
biu	bill
truth	truth*
truf	truf*
bill	biu
truf	truth