CROSS-LANGUAGE PERCEPTION OF NON-NATIVE STOPS AND FRICATIVES AMONG MALAY AND HAUSA NATIVE SPEAKERS

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ABSTRACT

This study examines the effect of native language on listeners’ perception of native and non-native consonants. The study focuses on cross-language perception of selected stops and fricatives among Hausa speakers who have little exposure to Malay, and Malay speakers who have no exposure to Hausa. The primary goal of this study is to examine how Hausa and Malay speakers perceived non-native stops and fricatives that are absent in their native language. Hausa language has a combination of plosives and implosives which involves the use of different airstream mechanisms in their production. Malay speakers who do not have any experience of implosives may find it difficult to discriminate between implosives and plosives, and to produce implosives accurately. In contrast, Hausa speakers may have difficulty discriminating between labial stops and fricatives in Malay as this distinction is not present in Hausa. Forty-five Hausa native speakers and forty-five Malay native speakers were recruited for the study. Audio-recording of minimal pairs of Malay and Hausa words were used as stimuli in an AX discrimination task. Subjects had to indicate whether they heard two different words, or the same words presented twice by two different speakers. The results of the study show that the Malay and Hausa native speakers faced considerable difficulties and problems in perceiving most non-native sound contrasts. Native language influence was found to be a major factor influencing the perception of non-native sound contrasts. This study concluded that the Perception Assimilation Model was successful in the prediction and interpretation of most of the perceptual difficulties encountered by the Malay and Hausa native speakers in the perception of stops and fricatives.

Keywords: speech perception, non-native, fricatives, plosives, implosives

INTRODUCTION

A number of studies of cross-language or second language (L2) speech perception have focused on the identification and/or discrimination of non-native contrasts that are absent in listeners’ first language (L1) such as English /l/ and /r/ for native Japanese listeners (e.g., MacKain, Best & Strange, 1981; Oh, Guion-Anderson, Aoyama, Flege, Guion, Akahane-Yamada & Yamada, 2011), and these studies have identified several factors influencing L2 learners’ success in identifying or discriminating English approximants. These factors include the location of the segment in a word, type of speech stimuli (natural vs. synthetic), lexical familiarity, previous linguistic experience and degree of perceived dissimilarity, among others. For instance, in a study on perception of approximants, Best and Strange (1992) showed that
cross-language discrimination accuracy depended on the cross-linguistic phonemic assimilation patterns and listeners’ experience with spoken English.

Thus far, there is ample evidence that native and L2 speakers of English differ in their perception of the voicing and/or place contrast in word-final consonants (e.g., Flege & Wang, 1989; Flege & Liu, 2001; Aoyama, 2003). In a recent study, Aoyama (2003) examined the perception of syllable-initial and syllable final English nasals by Korean and Japanese L2 learners. The Japanese listeners found it difficult to discriminate the /n/-/ŋ/ contrast in word-final position, but not the /m/-/n/ or /m/-/ŋ/ contrast although none of these nasal contrasts occur word-finally in their L1. It was observed that the English /m/ was assimilated to a single Japanese category, but the English /n/ and /ŋ/ were assimilated to multiple Japanese categories; hence resulting in perceptual difficulties for the learners. Similarly, Tsukada (2006) reported the perceptual ability of Australian English and Thai English bilingual listeners in the perception of word-final stops in English and Thai. The two groups discriminated the Thai contrast for /p/-/t/ best, particularly among the Australian English listeners. The listeners’ accuracy of discrimination was influenced by the type of stops they heard. The findings also show that first language transfer alone is not sufficient to account for learners’ patterns of response in cross-language speech perception since in the above study, the performance of the Australian English listeners was more accurate.

In another study, Tsukada (2007) examined the discrimination of word-final stop contrasts (/p/-/t/, /p/-/k/, /t/-/k/) in English and Thai by L2 listeners from diverse Asian language backgrounds (e.g., Cantonese, Korean, Indonesian, Vietnamese). The findings suggest that familiarity with specific phonetic realization of sounds (i.e., unreleased final stops) may play a facilitative role in perceptual flexibility. However, without exposure to native phonetic contrasts that include these detailed acoustic characteristics, it may be difficult to develop the capacity to discriminate subtle phonetic differences to the level of native listeners. In the same context, Holliday (2014) conducted a study on native Mandarin listeners’ perceptual assimilation of Korean obstruents. Different combinations of stops, affricates, and fricatives were used for the experiments with 20 native Mandarin speakers. The results revealed that affricates were perceived as post alveolar and alveo-palatal more frequently than as alveolar affricates. The finding also shows that vowel context influenced the perception of fricatives and affricates.

These results appear to be consistent with predictions generated by models of cross-language speech perception such as the Perceptual Assimilation Model (PAM) (Best, 1993; 1995). According to the PAM, instances of contrastive L2 categories that are identified as instances of a single L1 category (Single Category Assimilation) as found in the perception of English /l/-/r/ for Japanese learners, will be relatively difficult to discriminate. However, instances of contrastive L2 sounds that are mapped onto two different L1 sounds (Two-Category Assimilation) as found in the mapping of /w/-/j/ in English and Japanese will be discriminated more accurately.

The findings and recommendations of the previous studies concerning the perception of fricative sounds and important acoustic cues that are associated with the perception of fricatives, however, indicated some limitations. Specifically, it is observed that most of the studies carried out were on the perception of English fricatives by English as second language (ESL) learners. None was found on cross-language perception of fricatives among native speakers of two different languages. A recent study by Lago, Scharinger, Kronrod and Idsardi (2015) examined the relative acoustic contribution and information of phonology in terms of
perceiving fricative sounds. Two fricatives, /ʃ/ and /s/, presented at word initial position were used as stimuli. The results show that the fricatives were discriminated more accurately when they crossed a categorical boundary. Focusing on sounds with different manner of articulation, Alwan, Jiang and Chen (2011) studied the relevant perceptual acoustic cues for the place of articulation of plosives /b d p t/ and fricatives /f s v z/ at word initial positions in a noise condition. Relative spectral amplitude and frequency formants were examined for these segments. The study showed that vowel context, manner of articulation and voicing determined the perception of labial/alveolar distinctions in noise. Alwan, Jiang, and Chen (2011) also examined the relevant acoustic cues in the perception of syllable initial plosives /b p d t/ and fricatives /f v s z/. The findings revealed that the perception of alveolar/labial distinctions in noise was determined by the manner of articulation, voicing interaction as well as vowel context. The acoustic measurement and signal-to-noise-ratio (SNRs) indicated that the formant frequency measurements increased for the perception of alveolar/labial distinctions as the signal to noise ratio degrades.

In another study, Stevens et al. (1992) examined the factors that differentiate voiced and unvoiced fricatives. The result shows that listeners based their intervocalic fricative voicing judgments on the interval duration for which there was no vibration on the glottis. The findings revealed that fricatives could be judged as voiceless if the time interval was above 60 milliseconds (ms).

An important discovery in this review is that even when native and non-native languages share a phonetic contrast at the abstract phonological level, listeners may fail to show accurate perception in the non-native stimuli. In other words, positive transfer from L1 may not be reflected in listeners’ performance. An example of this was demonstrated by Hallé, Best and Levitt (1999) for native French listeners’ perception of American English approximants /w j r l/. These phonemes occur in French with varying degrees of similarity to the target sounds. If L1-to-L2 mappings at the traditional phonological level predict cross-linguistic perception patterns, it is predicted that French listeners would not have difficulties with these English sounds. However, it was found that the French listeners had some perceptual difficulties with the English /r/. This finding was attributed to marked articulatory-phonetic differences between the English and French /r/ (i.e. phonetically realized as a central approximant in English and a uvular fricative in French). Of the three contrasts tested (/w/~j/, /r/~l/, /w/~r/), the French listeners had most difficulty with /w/~r/ and tended to hear the English /r/ as /w/-like.

Since only limited counter examples of expected L1 positive transfer have been reported in the literature, it may be necessary to examine different non-native language comparisons before any generalization can be made. The present study sought to verify if positive transfer at the phonological level might be observed in word-initial position. The word initial context was chosen since phonetically, it is a more salient position. The word final context is also influenced by other phonological constraints such as English word final voice neutralization and phonotactic constraints against voicing contrast in Malay (Yap, 2013) and may be more difficult for perception because of these other confounding reasons. Hence, this study focused on the perception of native and non-native stops and fricatives in the word-initial position which are functional (i.e. phonemic) in both Malay and Hausa.

**Phonemic inventories of Hausa and Malay**
The Hausa language has a combination of plosives and implosives. However, in human languages, implosives are rare; linguists have encountered many problems in their descriptions,
as most of the world’s languages sounds are produced with the egressive pulmonic airstream mechanism (Ladefoged & Maddieson, 1996:77). In addition, to our knowledge, there is also hardly any study done on the discrimination between plosives and implosives. The lack of published work on implosives motivated this study as anyone who wishes to learn and speak Hausa has to be able to learn the contrast between plosives and implosives as these stops are phonemic in Hausa.

The Hausa language, which belongs to the Afro-Asiatic language family (Greenberg 1966), also stands as the most powerful language in terms of speakers and prestige among the Westerly sub-group of the Chadic language. It has considerable literature in the forms of poetry, prose and Islamic writings, written in a modified Arabic script (Ajami). In West African sub region, the Hausa language has the highest number of speakers. In Nigeria alone, the Hausa language has about thirty-three (33) million native speakers. It is a second language of about 15 million people and taken together, an approximate total of forty eight (48) million people in Nigeria (Eberhard, Simons & Fennig, 2019). The Hausas have dominated more than half of the demographic map of Nigeria. In the Republic of Benin, it has about 900,000 speakers; in Burkina Faso about 500,000 speakers; in Cameroon about 2,300,000; in Togo about 900,029 speakers; in Sudan about nine 918,000 speakers; and in Niger about 12,000,000 speakers are said to have been in existence (Eberhard, Simons & Fennig, 2019). The Hausa language is spoken across the West African sub-region, and it is also spoken in Central Africa, Chad, Congo, Eritrea, Saudi Arabia and North Western Sudan.

In standard Hausa, there are thirty-four (34) consonant sounds (Sani, 2005). Table 1 presents the Hausa consonantal chart.

<table>
<thead>
<tr>
<th></th>
<th>Bilabial</th>
<th>Alveolar</th>
<th>Post-alveolar</th>
<th>Palatal</th>
<th>Palatalized velar</th>
<th>Velar</th>
<th>Labialized Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plosive &amp; Affricate</td>
<td>b</td>
<td>t</td>
<td>d</td>
<td>tj</td>
<td>dʒ</td>
<td>ḳ</td>
<td>g̣</td>
<td>?</td>
</tr>
<tr>
<td>Implosive &amp; Ejective Stop &amp; Affricate</td>
<td>b̄</td>
<td>tʃ'</td>
<td>d</td>
<td>(tʃ')</td>
<td>j'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>Φ</td>
<td>s</td>
<td>z</td>
<td></td>
<td>h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap/Trill</td>
<td>r</td>
<td></td>
<td>t</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>w</td>
<td></td>
<td>j</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral Approximant</td>
<td>l</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

In contrast to Hausa, the Malay language is one of the members of the Malayic subgroup in the Austronesian family of languages. The Malayic subgroup has languages such as Gayo in Sumatra, Iban in Borneo, and Minangkabau in Sumatra (Eades & Hajek, 2006). Adelaar (2005) reported that many local Malay dialects are found in Sumatra, Borneo, Malaysian Peninsular, and parts of Eastern Indonesia. Different varieties of Malay are spoken in Malaysia, Brunei, Singapore and Indonesia; however, these varieties have mutual intelligibility as reported in Steinhauer (2013). With the influence of Javanese and Dutch, it
was reported that Indonesia is the most divergent, but the other varieties spoken in the Malayan Peninsular differed mainly phonetically and phonologically.

In the Malay language, there are twenty-four (24) native speech segments (18 consonants and 6 vowels) and nine (8) loan consonants which occur in loan words in Malay according to Nik Safiah Karim et al. (2008). Table 2 presents the consonants of the Malay language with some of the loan consonants presented in parentheses. However, the loan consonants that are less frequent and those that are usually assimilated into other existing phonemic categories have been excluded from the Table (see Nik Safiah Karim et al., 2009: 299).

Table 2: Malay consonantal chart (Source: Nik Safiah Karim et al., 1994)

<table>
<thead>
<tr>
<th></th>
<th>Labial</th>
<th>Alveolar</th>
<th>Post-alveolar</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
<th>Labial-velar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plosives/Affricates</td>
<td>p</td>
<td>b</td>
<td>t</td>
<td>d</td>
<td>c</td>
<td>j</td>
<td>k</td>
</tr>
<tr>
<td>Fricatives</td>
<td>(f)</td>
<td>(v)</td>
<td>s</td>
<td>(z)</td>
<td>(j)</td>
<td></td>
<td>h</td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
<td>n</td>
<td>j</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Trill</td>
<td>r</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>j</td>
<td></td>
<td>w</td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>l</td>
<td></td>
</tr>
</tbody>
</table>

Specific stops and fricatives were chosen from Malay and Hausa to be included in the design of the study and to enable comparisons to be made in the interpretation of the analysis. In this regard, implosives are found in Hausa but not in Malay, and likewise the voiceless bilabial plosive and the voiceless labio-dental fricative are found in Malay but not in Hausa. However, both languages have the same set of alveolar plosives and fricatives. The properties of the phonemic inventory of the two languages allow the researcher to examine the perception of the novel and familiar phonetic categories by naïve language learners.

Models of Speech Perception
As the present study investigated how Hausa and Malay native speakers perceived non-native stops and fricatives, the Perceptual Assimilation Model (PAM) (Best, 1993, 1994a, 1994b, 1995) and Speech Learning Model (SLM) (Flege, 1995) were adopted as the framework for the study. Similarities and differences between native language and non-native phonological systems may pose some difficulties in the perception and production of non-native contrasts (Flege, 1995). Research have shown that adult listeners of non-native language have significant difficulties in the perception of most, but not all, phonetic dissimilarity that are not functional in their native languages (Best & Tyler, 2007; Best et al, 1988; Flege, 1995; Kochetov, 2004). In this light, the present study aims to provide an account for the perception of non-native naïve listeners based on the current non-native models.

Specifically, the study examined how Malay native speakers discriminate between word-initial plosive and implosives in Hausa, and how Hausa native speakers discriminate word-initial plosive and fricatives in Malay. Implosives are found in Hausa but not in Malay, and likewise the voiceless bilabial stop /p/ and labio-dental fricatives, /f/ and /v/ are found in Malay but not in Hausa. However since the alveolar stops, /t/ and /d/ and the alveolar fricatives, /s/ and /z/ are found in both languages, these segments were included in the study as they provided a comparison for interpretation of the analysis.
METHODOLOGY

Participants
Ninety adults volunteered to participate in this study. The participants comprised Malay native speakers (29 females and 16 males) who were born and brought up in Malaysia, and Hausa native speakers (7 females and 38 males) who were born and brought up in Nigeria. They were recruited based on their native language backgrounds. The Malay listeners’ (n = 45) age range was between 23 and 42 years ($M = 27.40$), while the Hausa native speakers’ (n = 45) age range was between 27 and 52 ($M = 34.50$). All the Malay native speakers were born and brought up in Malaysia, while the Hausa native speakers were born and raised in Nigeria, but since they were also postgraduate students in Malaysia, they were not completely naïve to Malay. However, most of them did not indicate that Malay and the other local languages such as Chinese and Tamil as a foreign language (see Table 3) that they were fluent or proficient in although they could possible use some rudimentary words and phrases in these local languages when communicating with the locals in Malaysia. The Malay participants as well as the Hausa participants also have knowledge of another language, namely, English. Both groups of participants (Malay and Hausa) use English language to communicate with non-native speakers of their languages.

<table>
<thead>
<tr>
<th>Native Groups</th>
<th>Gender</th>
<th>Age</th>
<th>Knowledge of Foreign Language</th>
<th>Language Often Used</th>
<th>Language Used with Non-native Speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malay</td>
<td>16 (36%)</td>
<td>29 (84%)</td>
<td>23-42 (Mean = 27.40)</td>
<td>English (83%) Arabic (9%) German (2%)</td>
<td>Malay (72%) English (22%) French (6%)</td>
</tr>
<tr>
<td>Hausa</td>
<td>38 (64%)</td>
<td>7 (16%)</td>
<td>27-52 (Mean = 36.50)</td>
<td>English (89%) Arabic (7%)</td>
<td>Hausa (62%) English (36%) Fufulde (2%)</td>
</tr>
</tbody>
</table>

A purposive sampling based on the results of a demographic questionnaire was first employed to recruit the participants. The demographic questionnaire, which was adapted from the questionnaire of Montrul (2012) was used to filter the population so that the samples would comprise native speakers of Malay and Hausa. Apart from gender and name, pertinent information on the participants’ language of instruction, native language background, knowledge of foreign languages, linguistic history, and linguistic background, and so forth were also elicited. All questions in the questionnaire were designed to elicit essential information to ensure homogeneity of the respondents within each language group and to prevent cases where the participants are not Malay or Hausa native speakers. Table 3 summarizes the results of the demographic questionnaire.

Instruments
The study used a questionnaire to elicit background information of the respondents as described in the earlier section. To ascertain the performance of the respondents for cross-language perception of specific segments in Hausa and Malay, PRAAT (Boersma and
Cross-Language Perception of Non-Native Stops and Fricatives Among Malay and Hausa Native Speakers

Weenink, 2018), a computer programme which can analyse and run speech perception experiments, was used to collect the data for the study.

Audio-recordings of Hausa and Malay minimal pairs with the target speech segments were used as stimuli. The target sounds (stops and fricatives) were presented at word initial position. The stimuli were recorded by two male native Hausa speakers and two male native Malay speakers in order to ensure a standard and accurate pronunciation of the target segments. The two Hausa speakers were graduate students at a public university in Malaysia, one at the master level, the other at the doctoral level and both were conducting research on English and Hausa phonetics. The two Malay speakers were also graduate students of at a public university in Malaysia at the master level conducting research on the Malay language. The Malay speakers age ranges between 22 and 24, while the Hausa speakers age ranges from 27 to 33. The use of multiple speakers (2 Malay and 2 Hausa) was essential for the discrimination task as it ensured that the decisions were not made based on acoustic peculiarities from one speaker, such as pitch, intonation, or any other voice specification. All the stimuli were recorded with a Logitech Wireless Headset h600 microphone and PRAAT, the software program for speech analysis (Boersma & Weenink, 2001). The sampling rate used in the recording was 44100 Hz. The recordings were done in a quiet room, and each sentence was recorded once from the four speakers. The words for the discrimination task were extracted from the sentences using PRAAT and the discrimination experiment was also designed using PRAAT.

Each stimulus from the two languages (Malay and Hausa) was recorded in the carrier phrases shown below.

(1) Malay carrier phrase: *Baca ... sekarang ‘read ... again’*
(2) Hausa carrier phrase: *Ya....sam ‘3sg pronoun ... again’*

The use of the carrier phrase was important to determine the onset of the stops (Kang, 2014; Ogut, et al., 2006). The carrier phrase also helped to maintain the important acoustic cues which can be deleted if the recordings were done in isolation. In particular, it would be difficult to determine the closure duration which could be an important acoustic cue for the distinction of plosives and implosives. The carrier phrases were chosen to ensure that the target phonemes were all presented following a vowel to enable the closure phase and the release phases of the stops to be captured more accurately.

The Hausa and Malay minimal pairs that were recorded and used for the perceptual discrimination task are shown in Table 4. The researchers have chosen disyllabic words to ensure that both words are minimal pairs as Malay and Hausa words are usually disyllabic (Abubakar, 2001; Newman, 2000; Sani, 2000).

<table>
<thead>
<tr>
<th>Hausa words</th>
<th>IPA Transcriptions</th>
<th>Malay words</th>
<th>IPA Transcriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>daba - taba</em> ‘horse riding – cigarette’</td>
<td>/dáːba:/ vs /táːba:/</td>
<td><em>fasa - pasar</em> ‘phase – market’</td>
<td>/fasa/ vs /pasar/ [fasa:] [pasa:]</td>
</tr>
<tr>
<td><em>zara - sara</em> ‘pull out something – cut’</td>
<td>/záːra:/ vs /sáːra:/</td>
<td><em>visa - bisa</em> ‘visa – possible/poison’</td>
<td>/visa/ vs /bisa/</td>
</tr>
<tr>
<td><em>bata - bata</em> ‘spoil – bottle’</td>
<td>/báːta:/ vs /báːta:/</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Stimulus items for the discrimination task
The phoneme /f/ was paired with /p/ while /v/ was paired with /b/ as the phoneme /f/ and /v/ are absent in Hausa phoneme inventory (Sani, 2015). Also, /f/ and /p/ were paired with one another as they both share the labial and voiceless feature and it has been recorded in the literature that Hausa speakers often confuse these two segments by producing [f] when [p] is expected (Maiunguwa, 2015). As for the Malay words, loan words such as visa and fasa are usually pronounced with the final [a:] and not with the schwa as noted in Asmah (2008:164) for loan words ending with the letter <a> in Malay. However the word bisa can be pronounced with a schwa or with the final [a:]. Care was taken during recording to ensure that the words bisa and pasar were pronounced as intended to ensure that the words presented in the task were minimal pairs. The final /r/ is pasar is not realized resulting in lengthening of the preceding vowel (Yunus Maris, 1980; Asmah, 2008). The word bisa is therefore ambiguous in meaning as it could refer to ‘poison’ pronounced with the standard pronunciation or it could refer to ‘possible’ in Indonesian Malay.

The perception task employed in this study is a discrimination task, whereby discrimination is “the act of differentiating two or more stimuli presented in some predefined format” (Logan & Pruitt, 1995). As Pisoni and Liverly (1995) explain, a discrimination exercise promotes “acquired distinctiveness”. In the AX categorical (same-different) discrimination task, the subjects’ task was to specify whether or not two stimuli in randomized word pairs were exemplars of the same phonetic category. In this study, the discrimination task was chosen as it taps phonological knowledge directly without mediation of lexical knowledge. Also, the stimuli used were non-native to listeners, it is appropriate to use a discrimination task, and not the identification task which taps into lexical knowledge (Tsukada, 2006; Tsukada, 2008). Therefore, listeners had to form some kind of mental representation of the phonetic categories under comparison instead of directly comparing stimuli on the basis of physical identity or mediate it via their lexical knowledge. Stimuli in the same pairs were physically different tokens drawn from the same phonetic category, while stimuli in different pairs were drawn from distinct categories. This type of discrimination task was used widely in cross-language studies (e.g. Strange & Dittmann, 1984; Ratos, 2014; Tsukada, 2006; Tsukada, 2008).

**Experimental Procedures**

The participants were seated comfortably, almost 40 cm away from a laptop computer in front of them, wearing a microphone headset. In the discrimination task, the participants listened to two words presented through the headphone sets and had to decide whether they represented the same or different words. The subjects were presented with a total of 120 trials each. There were six sets of minimal pairs as shown in table 4. For each set of minimal pairs, two same pairs and two different pairs were constructed. For example for /v/-/b/, the same pairs were visa-visa and bisa-bisa, while the different pairs were visa-bisa and bisa-visa. These four stimuli pairs were presented five times resulting in twenty tokens for each set of contrasts. The task took every participant about 10 to 15 minutes to complete, depending on the participant’s response pace. Results for each participant were registered by the computer and transferred to an Excel Spreadsheet for processing and scoring. One (1) mark was assigned to each correct attempt and zero (0) mark for each incorrect response. The scores of each participant were then
RESULTS

Descriptive Results
The descriptive results show that the Malay native speakers discriminated the Hausa implosives-plosives contrasts poorly with lower correct percentages obtained [/ɓ-b/ : \(M = 36\) /ɗ-ɗ/ : \(M = 48\)] compared to the performance of native Hausa speakers who had high correct percentages [/ɓ-b/ : \(M = 80\); /ɗ-ɗ/ : \(M = 93\)]. In contrast, the correct percentages obtained for the discrimination of Malay fricative-stop contrasts for /f-p/ and /v-b/ by Malay native speakers was higher [/f-p/ : \(M = 87\); /v-b/ : \(M = 76\)] compared to the Hausa group [/f-p/ : \(M = 54\); /v-b/ : \(M = 51\)]. Both groups performed relatively well with the alveolar segments as shown by the high correct percentages for both pairs of control segments [Malay: /s-z/, \(M = 84\), /t-d/: \(M = 83\); Hausa: /z-s/, \(M = 85\), /t-d/: \(M = 86\)]. See Figure 1.

The results obtained from the discrimination of Malay fricative-stop contrast show that the Hausa native speakers were unable to discriminate the following pairs of contrasts: /f-p/ and /v-b/ with the correct percentage of only 54% and 51%, respectively. Since there were only two options available for their response, the results seem to be hovering around the guessing rate of 50%. This shows that the Hausa native speakers were less accurate than Malay native speakers when they heard the Malay fricative-stop contrasts. However, their discrimination accuracy depended on the type of contrasts they heard. Some contrast such as /f-f/ and /v-v/ were easier to discriminate with 66% and 64%, respectively. Contrasts such as /f-p/ and /v-b/ were more difficult to discriminate with only correct scores of 42% and 37%, respectively. Moreover, the results supported the claim made by the current research on non-native speech perception, as not all non-native segmental contrasts are equally difficult. Some are discriminated moderately well, and others at near native-like levels (Best, McRoberts & Sithole 1988; Best, McRoberts & Goodel, 2001; Best & Strange, 1992; Kochetov, 2004).

Figure 1: Correct discrimination percentages for Malay and Hausa native speakers
The independent sample t-test was conducted to identify any significant differences between the results of the two groups of participants. The results of all the 12 different pairs are summarized and presented in Table 5. As shown in the table, a significant difference is found for all consonant pairs except for the contrasts between /s-z/ and /t-d/ for both Hausa and Malay. The results show that the difference between the Malay and Hausa subjects are statistically significant for the plosive-implosive pairs as well as for the fricative-plosive pairs. The Malay subjects were unable to discriminate between plosives and implosives while the Hausa subjects were unable to discriminate between the fricatives and the plosives for /f-p/ and /v-b/. However, the difference between the two groups was not statistically significant for /s-z/ and /t-d/ as these contrasts were found in both Malay and Hausa; hence the speakers are sensitive to these contrasts.

DISCUSSION
This section discusses the results and major findings of the task for both Malay and Hausa native speakers, which include the level of difficulty encountered by the two groups of speakers in the discrimination of the various sounds contrasts discussed earlier. The results of the study were examined find out whether the perception of the contrasts was accounted for by existing models of speech perception.

Sound Contrasts Found in both Malay and Hausa Languages
The results obtained for the perception of fricatives and plosives /z-s/, /d-t/ supported the predictions postulated in the Perceptual Assimilation Model (PAM), where a two-Category
(TC) assimilation involving the mapping of the L2 contrasts to two categories in the L1 may result in ease of discrimination for the target L2 contrasts. The contrasts for /z-s/ and /d-t/ are found in both Malay and Hausa (Sani, 2005; Nik Safiah Karim et al., 2008). The phonetic experience of this contrast in the speakers’ L1 appears to be sufficient and results in positive transfer from the L1 to the L2 which facilitated performance in the discrimination task.

**Sound Contrasts Present in Malay Language and Absent in the Hausa Language**

The phonemes of these contrasts are sounds phonologically found in Malay phonemic inventory and phonologically absent in Hausa phoneme inventory. The sounds are the voiceless labio-dental fricative /f/ and the voiced labio-dental fricative /v/, and they are in contrast with /p/ and /b/, respectively. These pairs of contrasts were predicted by PAM to be difficult for Hausa speakers as a Single Category Assimilation may result in the collapse of the L2 contrast into a single L1 category. Hausa has the voiceless bilabial fricative /φ/ but not the voiceless labio-dental fricative, /f/ nor the bilabial plosive /p/. When presented with two words from the latter categories, Hausa speakers may assimilate both of these segments to the only voiceless labial segment it has, the voiceless bilabial fricative /φ/. When presented with two words that represent the voiced labial segments /b/ and /v/, Hausa speakers may assimilate the voiced labio-dental fricative to the only voiced labial segment it has, the voiced bilabial stop /b/.

The results obtained from the discrimination of Malay fricative-stop contrast show that the Hausa native speakers were indeed unable to discriminate the following pairs of contrasts: /f-p/ and /v-b/. The performance of Hausa subjects hovered around the guessing threshold of 50% although the /f-p/ was slightly higher (M= 54%) compared to the mean correct percentage for /v-b/ which was only 51%. The results support the claim made by the current literature on non-native speech perception, as not all non-native segmental contrasts are equally difficult. Some are discriminated moderately well, and others at near native-like levels (Best, McRoberts & Sithole 1988; Best, McRoberts & Goodel, 2001; Best & Strange, 1992; Kochetov, 2004). In the context of this study, the performance of the discrimination task was native like for the alveolar stops and fricatives as discussed in the earlier section, but the performance for labial stops and fricatives are poor as predicted by the Perceptual Assimilation Model (PAM) proposed by Best (1994).

**Sound Contrasts Present in Hausa Language and Absent in Malay Language**

The phonemes of these contrasts are sounds phonologically found in Hausa phonemic inventory and phonologically absent in Malay phoneme inventory. These sounds are voiced bilabial implosive /b/ and voiced alveolar implosive /d/. The results obtained show that the Malay native speakers, having no linguistic experience of Hausa implosives, failed to discriminate between the plosives and the implosives. This suggests that the acoustic differences may not be audible to the Malay native speakers. The results supported the predictions made by PAM Single-Category (SC), as the Hausa sounds contrasts are judged by the Malay native speakers as equally good or poor tokens of the only bilabial or alveolar stop category found in Malay. The two Hausa implosive sounds are assimilated to the Malay voiced plosives, which resulted in poor discriminations. The same instances were reported by Schmidt (1996), as Korean native speakers found it very difficult to discriminate /O-ŋ/, /tf-tf/, /p-b/, and /f-v/ contrasts in English as a result of single-category assimilation to Korean phonemes.
CONCLUSION

The analysis of the discrimination of the stops revealed that the Malay native speakers were able to discriminate most of the sounds contrasts but faced substantial problems in the perception of plosives-implosives. The Hausa native speakers, on the other hand, successfully discriminated all the implosives-plosives contrasts but they could not distinguish the labial fricatives and stops in Malay. The alternating pattern in the result of the two respondent groups indicated that the /ɓ-b/ contrast was difficult for the naïve Malay group while the bilabial stop and labio-dental fricative was difficult for the Hausa group despite not being completely naïve to these pairs of contrasts as the Hausa group has some exposure to Malay and are also second language learners of English where these segments are quite frequently encountered. Although the study did not examine the effect of proficiency in English on the performance of the subjects in the discrimination task, the contribution from proficiency in English seems to be minimal as the performance of the Hausa group was hovering slightly above the chance level.

This study also showed that the non-native perception model was successful in the prediction and interpretation of most of the perceptual difficulties encountered by the Malay and Hausa native speakers in the perception of stops and fricatives. The Perceptual Assimilation Model (PAM) predicts the success of adults’ monolinguals ability to discriminate unfamiliar foreign contrasts with little or no experience to the target language. The results of the analysis of the perception task pointed out that both the native speakers have problems in perceiving non-native contrasts as the non-native segment is often assimilated to the nearest native category that exist. In the case of implosives, Malay subjects considered them as members of the plosive stops found in Malay. As for the Hausa subjects, the voiced labio-dental fricative, /v/ was probably assimilated to the voiced bilabial stop, /b/ in Hausa.

However, it is not clear what happens with /p/ and /f/ as both phonemes are absent in Hausa. Although it was not tested directly in this study, it is possible that both segments were considered as members of the bilabial fricative /φ/ which exists in Hausa. Future studies can test this directly to examine the extent to which instances of /p/ and /f/ are considered good examplars of /φ/ in Hausa. Future studies should also explore whether performance in the task can be improved with directed attention to the plosive-implosive contrast in Hausa as well as the dental-bilabial contrast in Malay and English. These future directions of studies will provide important suggestions on how to ensure successful learning of these contrasts by second language learners.

REFERENCES


