Different Task Type and the Perception of the English Interdental Fricatives

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1. Introduction

The study of the influence of the native phonological system (L1) on second language (L2) speech perception has been growing since the 1940's (Bohn, 1995). Current models of L2 phonological perception or of L2 phonological learning (Flege, 1995; Kuhl & Iverson, 1995; Best, 1995; Escudero, 2005; Best & Tyler, 2007) have emphasized the role that accurate perception seems to play on accurate segmental production of the target language. It is generally believed that adults are language-specific perceivers and that the perception of the L2 segments occurs through the filter of the L1 sound system, at least in initial stages of L2 learning (Ellis, 1994; Schmidt, 1996; Harnsberger, 2001; Best, McRoberts & Goodell, 2001; Brannen, 2002; Wayland, 2007; Best & Tyler, 2007). Cross-language mapping studies with L2 naïve listeners have shown that discrimination of foreign sounds previously mapped as similar to L1 categories receive lower scores when compared to sounds mapped as dissimilar to the L1 categories (e.g., Best, 1990; Polka, 1991; Best, Faber & Levitt, 1996).

Jenkins and Yeni-Komshian (1995) report some factors that might interfere in L2 speech perception, particularly in experimental situations, such as the listener's age, his or her degree of experience with the L2, the acoustic saliency of the contrast, how prototypical the token is, whether the L2 sound is embedded in real or nonsense words, the syllabic position or phonological context that the token is inserted in, and the type of task condition used in the experiment.

This paper is concerned with the perception of the interdental fricatives by Brazilian learners of English as a foreign language (EFL) as regards the influence of the perception task on the processing of the stimuli. As Beddor and Gottfried (1995) assert, each type of perception assessment presents its advantages and disadvantages: while some tend to load the perceiver's memory, such an ABX discrimination test, others tend to be lighter and more straightforward, such as a labeling task.

The Brazilian Portuguese (BP) sound system does not have as many fricatives as the English inventory. The phonemes /f, v, s, z, ʃ, ʒ/ are present in both systems, whereas the interdental /θ/ and /ð/ are present only in English. The sections that follow will present a brief review of the literature is presented, in section 2; the participants, the materials, and the procedures in part 3, and the results and the discussion of the finding in section 4.

2. Review of literature

Empirical data have shown that some nonnative segments seem to be more difficult to perceive and produce than others. Lambacher, Marten, Nelson and Berman (1997) report that the fricatives show high error rates in identification tasks, both among native and nonnative speakers of English. Miller and Nicely (1955) found that, among sixteen consonants, /θ/ was the most difficult to identify in noise condition by native speakers. Similarly, Hayden, Kirsten, and Singh (1979) found that the identification of /θ/ received the lowest score among twenty two consonants.

In terms of acoustic properties, the fricatives are aperiodic turbulence, resulted from the passage of the airstream through a narrow constriction. Raphael (2005) argues that the duration of the frication of these sounds is often greater than that of other aperiodic segments, such as stop bursts or aspiration, and that the duration of the frication is greater for the voiceless fricatives than for their voiced counterparts. In the spectrum, the frequency of the interdental fricatives is spread, and the absence of a resonating cavity causes a relatively low intensity in the frication. As regards formant transitions, the transition of the second formant that precedes and/or follows a consonant offers an acoustic cue for segments in general. However, the identification of formant transitions of the interdental fricatives is critical and easily confounded with the transition of the labiodental fricatives, due to the low intensity of the frication of these segments (Harris, 1958, cited in Raphael, 2005:194).

With regard to perceptual difficulty and effects of L2 experience, Guion, Flege, Akahane-Yamada and Pruitt (2000) carried out a study which investigated the perception of word-initial consonants by Japanese and English speakers. The results show that some foreign sounds are consistently identified as an L1 category, while others are mapped as two instances of the L1 inventory. The latter condition was found with the phoneme /θ/, identified as the Japanese /s/ 39% of the occurrences, or the Japanese labial fricative /ɸ/ 38% of the instances. The results also showed that whereas length of L2 experience seemed to have influenced the discrimination of some consonants, it did not appear to have affected others, such as the pairs /ɹ/-/l/ and /s/–/θ/.

Schmidt's (1996) carried out a cross-language mapping study in which Korean EFL learners heard 22 English consonants, interdental fricatives included. She aimed at assessing whether there was a perceptual relationship between consonants in Korean and English, and the degree of perceived similarity between the two inventories. Schmidt found that (i) L2 experience did not influence category-goodness ratings of the segments, (ii) the interdentals were the least rated among the total number of speech sounds, and (iii) the /θ/ stimuli received the largest variety of labeling choices in Korean—eight different labels.

Concerning the perception of the target phonemes in relation to whether the L2 segment is inserted into words or nonwords, studies generated different results: while Yoshida and Hirasaka (1983) found that more detection of inaccuracies with nonwords than with real words, Brannen (2002) did not find a significant difference in the perception of the interdentals when comparing real words and nonwords.

With reference to the perception of the target phonemes and the phonological context they are inserted in, Lambacher et al. (1997) found that the perception of the voiceless interdental varied according to consonant and vowel contexts—it was best perceived in VC consonant contexts and rarely perceived in VCV contexts; while /u/ seemed to have favored the perception of the target phoneme, /ɛ/ appeared to have disfavored it.

As regards perception of inaccuracies in relation to word position, pronunciation misperception is more often realized in word-initial position than elsewhere, as Bond argues, "in a ration of two to one" (2005:294). Researchers (e.g., Bond, 2005; Bent, Bradlow & Smith, 2007) also claim that in word-final position perception and production of inaccuracies is more prone to be disregarded, as well as the perception of pronunciation inaccuracies of function words. According to Bond (2005), function words do not demand as much attention as lexical words, since they are usually unstressed in everyday conversation. This causes them to be "often misperceived or adjusted to fit the utterance" (p. 301), and, as a result, listeners do not direct their attention to function words, "adding or modifying them as needed" (p. 308).

In conclusion, the studies reviewed in this session demonstrated that the perception of the interdental fricatives tends to be difficult and, as Jenkins and Yeni-Komshian (1995) have suggested, some factors might be involved in this difficulty: the acoustic low salience of the sounds; the phonological context the sounds were inserted in, and whether they were

embedded in words or nonwords. What remains unanswered, and is the aim of the present study, is (i) whether the types of task used in the perception assessment may interfere in the listeners' performance, and (ii) whether the perception of the target phonemes is different when comparing lexical and function words. Next session describes the method used in order to examine these objectives.

3. Method, materials and procedures

3.1 Participants

Twenty-four Brazilian EFL learners participated in the study, seven women and seventeen men, aged from 15 to 23. All the participants began studying English after the age of seven, and no participant recalled having received formal specific instruction in English phonetics and phonology. They all self-reported normal hearing and speaking capacities.

They were divided into two groups—12 pre-intermediate learners, named here group I (GI), and 12 advanced, named group A (GA). Regarding language experience, GI had been learning English for an average of 1 ½ year, while GA for an average of 5 years. Although different L2 experience has not shown a positive effect in perception of the target phonemes with other L1 backgrounds, two learning levels were chosen in the present study mainly in order to verify whether L2 experience would influence the perception of Brazilian EFL learners.

Five male native English speakers constituted the control-group of native speakers (NS), ages ranging from 19 to 42. Three of them were from different parts of the United States and two from Australia. All reported that in their dialects the interdental fricative phonemes are phonologically distinctive.

3.2 Perception Test 1: The General Pronunciation Error Perception Test (GPE)

The purpose of this test was to verify whether the subjects were able to notice inaccurate *th* pronunciation when the interdental fricatives were inserted in a context of communication. A text was recorded by a Brazilian EFL speaker, who did not participate in the study, with problematic pronunciation both at the segmental and supra segmental levels. The recording was done on a Sony Minidisk, digitized and normalized by the Sound Forge 7.0 program.

Alongside the speaker's own production errors, he was asked to produce the target phonemes differently every time a word repeated in the text. The choice of the substitutions was based on a previous study that investigated the production of the target phonemes by Brazilian EFL learners (Reis, 2004a), which found that /θ/ was frequently replaced with /t/, /f/, and rarely with /s/. Hence, the word *think*, for example, appeared first as [fɪnk], secondly as [sɪnk], and finally as [tɪnk].All the voiced counterparts were replaced with [d], since this was the most frequent pattern of substitution found in the same study. All 21 occurrences of each target phoneme were mispronounced.

The participants were given an answer sheet in which the text was transcribed, they heard the recording twice and were asked to mark any pronunciation mistakes they could notice in word-initial position.

3.3 Perception Test 2: The Categorial Discrimination Test

In order to evaluate participants' discrimination of the interdental fricative phonemes in word-initial position from their most common replacements, the second perception instrument was the Categorial Discrimination Test (CDT, Flege et al., 1994).

The test consisted on an oddity format test consisting of 44 randomized trials (6 contrasts x 6 change trials = 36 + 8 catch trials)**.** The two minimal sets *thigh-fie-tie-sigh* and *thee-vee-dee-zee* were recorded on a Sony Minidisk by three women native speakers of English, then digitized and normalized for peak intensity at 6dB using the Sound Forge 7.0 program. They were then organized into the 22 trials for each target phoneme, which were randomized separately in Praat 4.2, in order to reduce the ordering effect. Intervals were set at 1.7 seconds for inter-stimulus, and 2.8 seconds inter-trials. The test was recorded on a CD to be played in attenuated sound booth.

In a CDT, participants hear a sequence of trials and are asked to indicate whether there is an odd item in each trial and, if so, in what position it is located. If all three items are identical, the catch trials, they are instructed to mark the label '0'. On the other hand, if it is a change trial and the odd item out is the first word heard, participants are asked to mark '1'; if it is the second word, the correspondent label is '2', and, finally, if the third word heard is the odd item, they should indicate the label '3'.

The participants were provided with a 6-set practice session, with feedback, before the task itself began. In the test they heard the trials only once and were asked to mark the discrimination according to the design of the CDT, as described above. In order to focus participants' attention, they were instructed to concentrate on the initial sound of each word.

3.4 Perception Test 3: The Alternative Forced Choice Identification Test

In order to verify whether the subjects were able to identify differences between the interdental fricative phonemes and their most frequent replacements, the third data gathering instrument consisted of an Alternative Forced Choice Identification Test (AFC, Beddor & Gottfried, 1995).

The participants heard the same set of words from the CDT—*thigh-fie-tie-sigh* and *thee-vee-dee-zee*—for the voiceless and voiced target phonemes, respectively, recorded by the same female native speakers of English. Each word appeared 5 times at random, totaling 40 trials, 20 for each phoneme. The words were presented in isolation with an interval of 2.7 seconds among the trials. The two interdental fricatives were tested separately, that is, first the 20 words with the voiceless *th*, and then the 20 words with its voiced counterpart. For the voiceless test the labels were 'f', 's', 't' and 'th', while the voiced test had the labels 'v', 'z', 'd', and 'th'.

The participants heard each trial once and were instructed to pay attention to the word-initial sound of the word they would hear, labeling the sound according to the four possibilities given. Again participants were provided a 6-set practice session with feedback before the experiment itself began.

The analysis of the perception tests was based on the following responses: (a) GPE—1008 occurrences, 504 of each target phoneme; (b) CDT—528 samples of each fricative phoneme, totaling 1056; and (c) AFC—960 responses, 480 for each target phoneme. The NSs performed the perception tests as well, resulting in 210 responses in the first test (GPE), 105 for each *th*; 220 answers in the second test (CDT), 110 for each target phoneme, and 200 responses in the third test (AFC), 100 for the voiceless *th* and 100 for the voiced counterpart. Since the participants were asked not to leave any trial without an answer, all 3654 trials of the three perception tests were completed. These answers were organized according to group and test and all responses were considered in the statistical analysis.

4. Results

4.1 Perception Test 1: The General Pronunciation Error Perception Test

To the best of our knowledge, this kind of task has not been used in perception tests, thus a threshold for native-like attainment has not been established.

Concerning the results of the voiceless *th*, of the 21 inaccurate tokens present in the recording 24% were detected by the NSs, 17% by the GA and 9% by the GI (Table 1). A Kruskal-Wallis test reveals a significant difference between the results of the three groups for the voiceless *th* ($H = 6.52$, $p = .03$). A Mann-Whitney test confirms significance between the NSs and the GI, ($Z = -2.04$, $p = .04$) and between the GA and the GI ($Z = -2.17$, $p = .03$). However, the test yields a non-significant difference between the NSs and the GA, ($Z = -.48$, $p = .64$).

Table 1. Accurate perception of /θ/ and /ð/ errors by the pre-intermediate (GI), the advanced (GA), and the native speakers (NS) groups in the Perception Test 1—GPE.

	/θ/ perception					/ð/ perception					Total		
Group	N	Ac.	%	M	SD	N	Ac.	%	M	SD	N	Ac.	%
GI	252	22	9	1.75	1.96	252	3	1.19	.25	.62	504	25	5
GA	252	42	17	8.5	6.66	252	2	0.79	.17	.39	504	44	8
NS	105	25	24	5	3.74	105	2	1.90	.40	.55	210	27	13

Note: N= Number of occurrences. Ac. = Number of accurate answer. (%) = Percentage of accuracy. M= Mean. SD= Standard deviation

Regarding the results of the voiced *th* perception, they suggest that this phoneme is nearly completely ignored by all groups: the NS group indicated the target phoneme as inaccurate in only 1.90%, whereas the GA and the GI indicated it in 0.79% and 1.19% of the time, respectively (Table 1). Due to the extremely low percentages of accurate discrimination of the voiced target phoneme, no statistical test was used to check any differences across the three groups.

In summary, the results of the GPE indicate a voicing effect in the perception of pronunciation errors of the *th*-sounds. Comparing the results of the perception of the voiceless and the voiced *th* within each group, using Wilcoxon signed rank tests, the NSs perceived the voiceless *th* more accurately than its voiced counterpart ($Z=-2.02$, $p=.04$). The same tendency was observed with the GI, ($Z=-2.38$, $p=.001$), and with GA ($Z=-3.07$, $p=.001$). Thus, the results of the GPE suggest that the voiced *th* is more difficult to perceive than is voiceless counterpart, and that L2 experience seemed to affect the accurate perception of /θ/ but not significantly that of /ð/.

In conclusion, the results of the GPE seem to support Schmidt's assertion that "learners are not free to notice whatever they want" (1990:144). Both EFL groups might be constrained by some of the factors that interfere in noticeability: task demands, learner's skill level, learner's attitude, and input saliency, among others (Schmidt, 1990). In addition, the test may have indicated that the participants lack a well-established category for the target phonemes.

The GPE seems not to sufficiently draw the participants' attention to a particular aspect of speech sound perception. Since attention is not always under voluntary control (Schmidt, 1994:17) a test like the GPE seems to allow the subjects to become more attentive to the communicative aspect of the speech than to segmental inaccuracies. Therefore, the GPE's findings are consistent with Van Patten's (1994) claim that attention is a very limited

conscious resource for language processing. Besides, Van Patten's (1994:32) hypothesizes that:

> H1. Learners process input for meaning before they process it for form.
> H1a. Learners process content words in the input before anything else.
> H2b. Learners prefer processing lexical items to grammatical items (e.g., morphological markings) for semantic information.
> H1c. Learners prefer processing "more meaningful" morphology before "less or non-meaningful morphology."
> H2. In order for learners to process form that is not meaningful, they must be able to process informational or communicative content at no or little cost to attention.

Therefore, maybe few mistakes were identified because the participants were more attentive to the meaning of the speech, thus to content words, rather than to segmental inaccuracies. Jenkins and Yeni-Komshian (1995) argue that when the token under analysis is embedded in real-time speech, accurate perception diminishes and the NL system seems to prevail over attention and classification abilities. In addition, Morgan and Demuth (1996) remark that function words are less salient than content words in natural discourse. What has to be borne in mind is that all word-initial voiced *th* are function words, which in turn, are embedded in real-time speech with the marked phoneme /ð/. McLaughlin (1987) asserts that "because human learners are limited in their information-processing abilities, only so much attention can be given at one time to the various components of complex tasks" (p.136).

Concerning the relation between learners' L2 level and attention, maybe experienced learners are also capable of comprehending the meaning more automatically, in such a way that "attention can be devoted to the other components of the task and a previously difficult or impossible task becomes possible" (McLaughlin, 1987:136). Thus, perhaps they have left over processing capacity for focusing on form, especially for the less marked phoneme /θ/ in relation to /ð/, and to content words in relation to function words.

4.2 Perception Test 2: The Categorial Discrimination Test

The analysis of the present study focuses on the results of the change trials first (the trials which had an odd-item), while the results of the catch trials (those in which all items are phonetically the same) will be discussed further.

The overall results of each target phoneme (Table 2) seem to demonstrate that there is a tendency for better discrimination of the voiceless *th* than of its voiced counterpart: for /θ/ discrimination the GI obtained 60% of accuracy, the GA 72%, and the NSs 81%, while for /ð/ discrimination the GI attained 59%, the GA 88%, and the NSs 77%. However, comparing the results of the target phonemes within each group, using Wilcoxon signed rank tests, no significant effect for voicing was found for either of the 3 groups: the NSs ($Z=-.44$, $p=.65$), the GI ($Z=-.41$, $p=.68$), and the GA ($Z=-1.39$, $p=.16$).

Concerning the results of the voiceless test, there seems to be a tendency for increasing discrimination from the GI to the GA to the NSs. However, a Kruskal-Wallis test reveals no significant difference among the results of the three groups for the voiceless *th* ($H = 4.93$, $p = .08$). In addition, a Mann Whitney test confirms the lack of significant difference between the NSs and the GI, ($Z =-1.77$, $p = .08$), the NSs and the GA ($Z=-.82$, $p=.44$), and the GA and the GI ($Z=-1.79$, $p = .07$). Thus, language experience seems to not affect positively the perception of the target phonemes in this kind of perception test.

Table 2. Accurate discrimination of change trials by the pre-intermediate (GI), the advanced (GA), and the native speaker (NS) groups, in Perception Test 2—CDT.

	/θ/ perception					/ð/ perception					Total		
Group	N	Ac.	%	M	SD	N	Ac.	%	M	SD	N	Ac.	%
GI	216	131	60	10.92	2,84	216	128	59	10.67	2.53	432	259	60
GA	216	157	72	13.08	2.81	216	143	66	11.92	1.88	432	300	69
NS	90	73	81	14.60	2.51	90	70	77	14.00	2.35	180	143	79

Note: N= Number of occurrences. Ac= Number of accurate answer. (%) = Percentage of accuracy. M= Mean. SD= Standard deviation

As regards discrimination of the voiced interdental, the NSs outperformed the GA, which in turn outperformed the GI: each group obtained 77%, 66% and 59%, respectively. A Kruskal-Wallis test reveals a significant difference among the results of the three groups for the voiced *th* (H=5.99, p=.05). Similarly, a Mann Whitney test confirms a significant difference between the NSs and the GI, (Z =-2.29, p=.02). However, no significant difference was found between the NSs and the GA (Z=-1.55, p=.12), or the GA and the GI (Z=-1.29, p=.29). Therefore, language experienced does not seem to influence perception of the voiced target phoneme.

In summary, the change trials of the CDT demonstrated that there is only a tendency for better discrimination of voiceless *th* than of its voiced counterpart, and that L2 experience do not affect positively the perception of the interdentals.

Table 3 illustrates the comparison of general participants' attainment in the two kinds of trials, change and catch, considering the results of the two phonemes together. Overall, the results show that the participants performed better with catch trials (when all words where identical), than with change trials (when there was an odd item).

Table 3. Accurate discrimination of /θ/ and /ð/, in catch and change trials, by the pre-intermediate (GI), the advanced (GA), and native speaker (NS) groups, in Perception Test 2—CDT.

	/θ/ and /ð/ change trials			/θ/ and /ð/ catch trials		
Group	N.	Acc.	%	N.	Acc.	%
GI	432	259	60	96	72	75
GA	432	300	69	96	70	73
NS	180	143	79	40	36	90

Note: N= Number of occurrences. Acc= Number of accurate answer. (%)= Percentage of accuracy.

The discrimination of the change trials was as follows: 60% by the GI, 69% by the GA, and 79% by the NSs. On the other hand, the discrimination of the catch trials was: 75% by the GI, 73% by the GA, and 90% by the NSs. Indeed, it was more difficult for the participants, both the EFL learners and the NSs, to accurately discriminate the target phonemes from their variants than to perceive that there was not a contrast within the trial. According to Flege et al. (1994), results such as these may be due to the design of the test, which might entail an intense load on working memory, because in the CDT the participants have to not only perceive a difference but also to remember the position of the odd item. In addition, in the present study each item of the trial consisted of a word, which would impose even more load on working memory than if the item was composed only of phones. The results show that, although the task seems to be demanding (in terms of overloading participants' memory), the participants appeared to be reasonably concentrated, since the EFL participants managed to identify over 70% of the catch trials.

This aspect of the test, the use of words, may also explain the low achievement of the NSs. Their attainment was much inferior to what Flege and colleagues consider being an appropriate native achievement, an average of 97% for change trials, and 99% for catch trials (Flege et al., 1994). Sozinho (2004), investigating perception and production of compound noun stress patterns in English by the means of a CDT, found that perception among native speakers was below Flege's estimation, about 86%. Similarly, examining the perception and production of English word-final nasals, Kluge (2004) verified that the NSs were able to discriminate an average of 78% of the trials accurately. As these researchers affirm, the results of the CDT in both studies seem to question the validity of the test for examining stress pattern and consonant discrimination. Besides, Kluge points out that "the original Categorial Discrimination Test was designed to assess the perception of vowels; thus, the estimated success rate suggested by Flege may not be a realistic expectation for the perception of consonants" (2004:45). Although the investigation of this caveat in the method is beyond the scope of this study, it is important to keep in mind that Flege and colleagues have been working with vowel perception and significantly smaller units in the trials. As he acknowledges (Flege, 1990, 1995) vowel and consonant perception may occur through different processes.

In conclusion, the CDT revealed that these Brazilian EFL learners tend slightly to discriminate the voiceless target phoneme and its variants better than the voiced set. In addition, the results of the test suggest that there seems to be an interaction between L2 experience and markedness. In other words, it seems that L2 experience may eventually influence the discrimination of the less marked /θ/, but not of the more marked /ð/.

4.3 Perception Test 3: The Alternative Forced Choice Identification Test

The results of the AFC test demonstrate that, in general, these participants are able to identify the target phonemes and their most common substitutes (Table 4). The AFC was the test in which the listeners obtained the highest scores out of all three perception tests: the GI identified 87% of all occurrences, the GA obtained 91%, and the NSs 95%.

Table 4. Accurate identification of voiceless and voiced interdental sets by the pre-intermediate (GI), the advanced (GA), and the native speaker (NS) groups, in Perception Test 3—AFC.

	/θ/ perception					/ð/ perception					Total		
Group	N	Ac.	%	M	SD	N	Ac.	%	M	SD	N	Ac.	%
GI	240	207	86	17.25	1.96	240	212	88	17.67	1.83	480	419	87
GA	240	223	93	18.58	1.31	240	213	89	17.83	2.17	480	436	91
NS	100	95	95	19	1.73	100	96	96	19.20	1.30	200	191	95

Note: N= Number of occurrences. Ac= Number of accurate answer. (%) = Percentage of accuracy. M= Mean. SD= Standard deviation

However, to the best of our knowledge, a threshold for native attainment has not been established for this kind of identification test. Comparing the results of the target phonemes within each group, using Wilcoxon signed rank tests, no significant effect for voicing was found for either of the 3 groups: the NSs (Z=-.18, p=.85), the GI (Z=-.30, p=.76), and the GA (Z=-1.36, p=.17).

Concerning the results of the identification of the voiceless consonants, the NSs obtained 95% of accuracy, the GA achieved 93%, and the GI 86%. A Mann-Whitney test reveals that there was no statistically significant difference between the NSs and the GI (Z = -1.77, p = .08), between NS and GA (Z=-.82, p=.40), or between the two EFL groups (Z = -1.79, p = .07). Although the statistical tests do not confirm a significant difference, the

difference between the NSs and the GI, and that of the learners came close to significance, which may indicate a tendency for L2 experience effect.

Regarding the results of the voiced identification set, the NSs attained 96% accuracy, the GA 89%, and the GI 88%. A Mann-Whitney test reveals no significant difference between the results of the NSs and the GA ($Z = -1.36$, $p = .19$), the NS and the GI ($Z = -1.67$, $p = .10$), or the two EFL groups ($Z = -44$, $p = .61$). Thus, L2 experience seems not to have influenced the identification of the voiced phonemes.

In summary, as with the discrimination results, the identification of the voiceless interdental fricative seems to show a tendency for L2 experience effect, which is not found for its voiced counterpart. Contrary to what was found for the other perception tests, the results of the AFC do not support the prediction that the more marked phoneme /ð/ would be more difficult to perceive that the less marked /θ/.

5. Discussion

All in all, the results of the three perception tests suggest that L2 experience does not significantly affect the perception of the target phonemes. It seems that there is only a tendency for improvement in the perception of the less marked phoneme over time, whereas its voiced counterpart appears not to be significantly influenced by L2 experience. The results are inconclusive about the issue of whether one target phoneme is more difficult to perceive than the other—while GPE indicates that /ð/ is more difficult that /θ/, the CDT shows only a tendency, and the AFC does not support the prediction.

In addition, the results of the three perception tests, particularly of those of the GPE, appear to support two related viewpoints: (a) Van Patten's (1994) hypotheses about conscious attention as a limited resource, and (b) Schmidt's assertion that "learners are not free to notice whatever they want" (1990:144). Both EFL groups might have been constrained by some of the factors that interfere in noticeability, such as task demands, learner's skill level, and saliency of the token (Schmidt, 1990).

In terms of saliency, the interdental fricatives are often perceptually confused with stops by children acquiring English as L1 (Eilers & Minifie, 1975). Acoustically, spectrograms demonstrate that /θ/ and /f/ are so similar that it is common for them to be confused by listeners (Ladefoged, 2001; Lambacher et al., 1997). Furthermore, the pairs /θ/-/f/ and /ð/-/d/ are mentioned as being among the most difficult contrasts to be distinguished (Eilers & Minifie, 1975; Polka, Colantino & Sundara, 2001). Miller and Nicely (1955) found that under noisy conditions adults usually confuse the low salient fricatives /θ/ and /f/.

Another aspect that should be taken into consideration is that both phonemes are introduced early in the process of EFL learning, particularly the voiced *th*, a phoneme found in word-initial position only in function words. As Morgan and Demuth (1996) point out, "function words are less salient forms in natural discourse given that they are short, contain unstressed vowels, are typically not produced in isolation, and are not highlighted by intonation" (cited in Polka, Colantino & Sundara, 2000:2198). Even when this class of words is inaccurately produced, in contrast to content words, their meaning can frequently be recovered from the context (Abrahamsson, 2003).

Still another aspect that must be taken into account is whether these EFL learners received accurate phonetic input (Flege, Munro & MacKay, 1996). A pilot study conducted to examine the perception and production of the target phonemes by proficient Brazilian speakers of English (Reis, 2004b), the majority of them English teachers, found production inaccuracies with the target phonemes in 52% of occurrences of /θ/, and 95% of /ð/. This finding might suggest that many Brazilian EFL learners are not receiving adequate *th* input in

order to build a proper L2 perceptual target for guiding their L2 perception (Flege et al., 1996).

As Strange (1995) points out, there may be an age limit for learning new perceptual segments without much difficulty. The participants of the present study had had their first contact with the English sound system at an average age of 10 years, and Strange argues that "first language patterns of perception are well in place by 5 years of age" (1995:35). Flege (1995) argues that after the stabilization of the L1, when children learn how to write and read, L2 learning may become more constrained than before L1 systematization.

Concerning learners' proficiency level, the results of the perception tests suggest that, in general, L2 experience does not seem to significantly influence the perception of the target phonemes. While perception of /θ/ appears to be slightly affected by language experience, perception of /ð/ seems not to receive the same influence. The aspects discussed above, such as the low acoustic intensity of the interdental fricatives, their acoustic similarity with other phones, their markedness characteristic, their early introduction into speech production, probable inadequate phonetic input, and the fact that the voiced *th* is only present in word-initial position in function words, might be some causes of the lack of influence of L2 experience on the perception of the target phonemes.

Furthermore, the perception tests used in the present study can be classified more form or meaning focused—the GPE could be considered more meaning-focused, whereas the CDT and AFC are more form-focused. Van Patten (1994) argues that L2 learners process input for meaning rather than for form. In a test such as the GPE, even when the participants are processing with guided attention, since they were asked to pay attention to the sounds in word initial position, they seem to ignore pronunciation mistakes that do not lead to misunderstandings, and tend to detect more errors in content words than in function words. The CDT and the AFC, on the other hand, are tests in which there is no content to be understood; thus the listeners may allocate their attention more acutely to what they are told to.

Following this reasoning, the tests present different levels of task demands, which can ultimately interfere in the participants' performance. Thus, the CDT and the AFC could be considered actual perception tests, in terms of how often the L2 learners are able to detect whether a non-contrastive phoneme in their L1 can be perceived or not as a distinct sound. On the other hand, the GPE could be described as a test that verifies the allocation of attention the participants give to a certain item.

All in all, the findings of the present study have indicated that the perception of the interdental fricatives is affected by type of perception assessment and by type of word, whether content or function words. While in a meaning-focused test content words seem to draw the listeners' attention to pronunciation more often than function words, form-focused tests tend to lead to higher scores than meaning-focused tests.

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