

THE PRODUCTION AND PERCEPTION OF ENGLISH, FRENCH AND GERMAN INTONATION

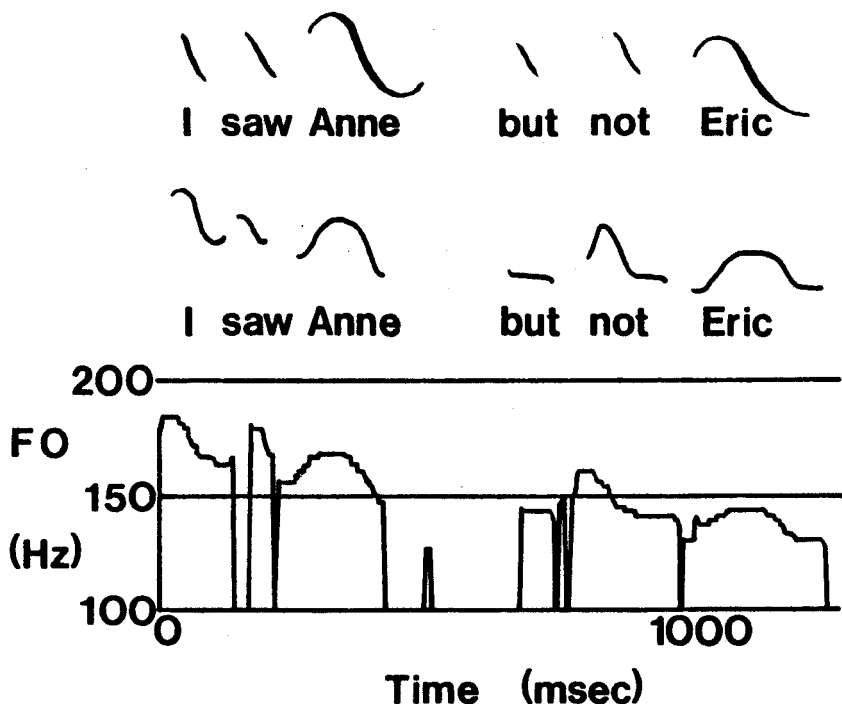
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'Foreign accent' has generally been equated with non-native pronunciation and much research has focused on the area of non-native pronunciation (for example, Briere 1966, Flege 1980). We were interested in other components of non-native speech which create or add to the listener's impression of 'foreign accent'. Specifically, we were interested in the role intonation plays in identifying a non-native speaker. It is not known how widely intonation is used to identify speakers of a different language or dialect. This unanswered question forms the central inquiry of this paper.

It is known that syllables, words and phrases are characterized by language-specific pitch (fundamental frequency, or F_0) patterns (Delattre 1963) and that there are differences in the manifestation of the same intonation functions across languages (Hadding-Koch and Studdert-Kennedy 1964, Cruttenden 1981, Delattre 1972). For example, Figure 1 shows the characteristic English reverse S shaped pitch patterns (generally falling pitch ending with a small pitch rise) over most of the words in the sentence. Also evident is the large fall in pitch indicating that the sentence will continue. This pattern for the continuative function is particular to English.

Figure 1. Native English Intonation Pattern.

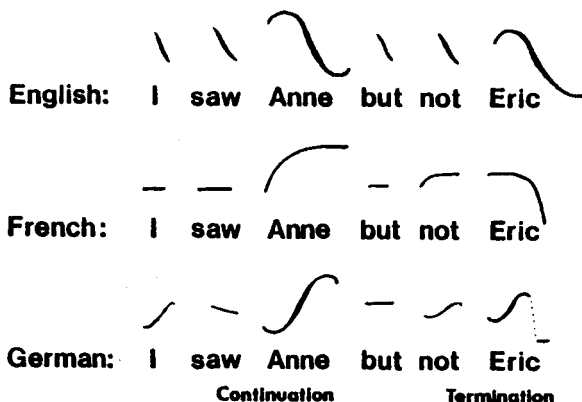
The height of the curved lines above words indicates pitch movement and the thickness of the lines represents intensity. The uppermost example is theoretical (adapted from Delattre 1963:194), while the middle example is based on a sample of real speech whose pitch has been analyzed, as represented by the graph at the bottom.



Since languages differ in their intonation patterns, a speaker may be identified as a member of a certain linguistic group by his intonation (Delattre 1963, Cruttenden 1981). Delattre (1963) further claims that speakers tend to impose their native intonation patterns on their second language. This is called intonational interference and, according to Delattre, contributes to the perception of non-native accent. One would then expect a French native speaking English to carry his native French intonation patterns over into his spoken English (as shown in Figure 2).

Figure 2. Interference of Native French and German Intonation Patterns with English Intonation (adapted from Delattre 1963:194).

The native English intonation pattern (top) is not used by non-native English speakers, who use intonation patterns typical of their native language when speaking English. The intonation patterns for a French speaker and a German speaker speaking English are given (middle and bottom, respectively).



Since French syllables, words and phrases are characterized by steep pitch rises and falls to and from plateaus, and continuation is expressed by a pitch rise instead of a pitch fall, one would expect that an English listener might decide on the basis of these intonation cues that the speaker was not a native speaker of English.

Interference by one's native language in one's second language is an acknowledged stumbling block in the acquisition of a second language (Dulay and Burt 1972, Taylor 1975), although there is some debate as to its pervasiveness at all age levels or in all areas of second language acquisition (Cook 1973, Palermo and Howe 1970).

The experiments presented here attempt to determine whether the intonation of a speaker's native language contributes to his perception and production of a non-native accent. Intonation is used here to mean pitch movement in speech as it reflects linguistic functions. Two linguistic functions, continuation and termination, served as the basis for an investigation of this question.

Continuation is that property of an intonation which shows that a speaker's utterance has not yet ended and that more will be said (Bolinger 1958, Bolinger 1970, Delattre 1963, Delattre 1972). Another such pattern is terminal intonation. Termination is conveyed by an intonation pattern which mainly indicates that the utterance has finished.

Delattre (1963) predicts that continuation and termination will both be conveyed by pitch falls in English. In French, continuation would be conveyed by a pitch rise and termination by a pitch fall. In German, continuation would be characterized by pitch rising to a high level pitch and termination would be conveyed by a rise before an abrupt fall to a level pitch.

Among the problems associated with the question of cross-language differences in intonation is convergence of function. A speaker's emotional state, his language background and linguistic information may all be conveyed by one intonation. Often, the intonation patterns used by speakers of an unfamiliar dialect will be misinterpreted as signalling an emotion or an attitude (Cruttenden 1981), rather than simply marking the speaker as non-native.

Work by some researchers sheds light on the possibility of identifying non-native speakers by their intonation. Tests of subjects' mimicry or identification of foreign intonation patterns suggest that subjects can perceive the differences between the intonation patterns of different languages (Neufeld and Schneiderman 1980, Tahta, Wood and Loewenthal 1981, Gilbert 1980). It is then possible that these perceived differences could be used to identify a non-native speaker. A methodological problem is that second language learners' intonation is judged in the presence of their second language pronunciation, which may influence the native speaker judges. The Neufeld and Schneiderman (1980) and the Tahta et al (1981) studies may both be faulted on this ground. A method of analysis was sought which would not be susceptible to this criticism.

We decided to conduct a computer pitch analysis using the intonational component slope (Delattre 1963). It was assumed that a physical analysis of pitch would not be influenced by the non-native accent of the subjects. It was expected that cross-language differences in the continuative and terminal intonation patterns could be represented as differences in pitch slope.

The slope is the steepness of the rise or fall in pitch over time. Our expectation was that pitch rises and falls in French would be steeper than those in English. We expected that the slopes associated with continuative intonation would be positive for French and German, indicating rising pitch, and that they would be negative for English, indicating falling pitch (Delattre 1963).

Slope may be measured as the maximum change in pitch over time, that is, maximum change in F_0 (fundamental frequency) divided by maximum time. Delattre (1972) contended that continuative and terminal functions are manifested minimally over syllables, usually over words, and sometimes even over phrases. For consistency's sake, we measured the slope only over words. We measured the slope over words before a phrase or clause boundary since linguistic functions such as continuation and termination are known to be manifested chiefly at these points in a sentence (Bolinger 1970, Dobrovolsky 1980).

There is some disagreement about proposed intonation patterns. Pierrehumbert (1981) and Bolinger (1958 and 1970) suggest that the continuative intonation pattern rises in pitch in English, while Delattre (1963) states that it falls.

There is also disagreement about the importance of the parameters used to represent intonation patterns. Delattre's 'shape' is considered circumstantial within English by Pierrehumbert, thus implying that slope is an irrelevant characteristic of an English intonation. Whether slope is unimportant when comparing intonations across languages remains to be seen. It is entirely possible that an element which is not used distinctively within a language might well be employed by native speakers comparing their own language intonation patterns to those of other languages.

Another difficulty is that there appear to be a wide variety of acceptable intonations for the same function. Although speakers recognize a given intonation pattern as native, they may use a somewhat different pattern for the same function in their own speech. Sag and Liberman (1975) note that all that can be said with assurance is that speakers always use intonation patterns which are acceptable to other native speakers.

A set of hypotheses about non-native intonation perception and production can be formulated from reported results and theoretical proposals in the literature.

1. Each language may employ different intonation patterns to show continuation and termination (Delattre 1963 and 1966).
2. A speaker imposes his native intonation patterns upon a second language which he has not mastered (Delattre 1963 and 1966).

3. A native listener will realize that his interlocutor is non native by attending to his non-native intonation. Thus intonation provides one sufficient cue to the perception of a non-native accent (implied by Tahta, Wood and Loewenthal 1981 and Neufeld and Schneiderman 1980).

It is necessary to first consider the following hypothesis about the measurement of cross-linguistic intonation, so as to have a basis for investigating the three hypotheses listed above.

4. Slope is significantly different across English, German and French intonations for both the continuative and the terminal functions (Delattre 1963 and 1966). If this is so, then slope might potentially serve as one intonational parameter speakers could use to identify non-native speakers.

EXPERIMENT 1

Our first aim was to confirm that the postulated language-specific intonation patterns existed. In particular, we expected the slope of the continuative and terminal intonation patterns to differ across English, French and German.

Materials

A set of 48 sentences was created with similar semantic and syntactic patterns for all three languages. It was assumed that any declarative sentence would end with a terminal intonation, indicating that the speaker had finished his message. Continuative intonation patterns were elicited by using bi-clausal or bi-phrasal sentences housing a pair of semantically linked propositions. The sentences are presented in the appendix.

The same continuative or terminal function was performed by the intonation at approximately the same place in the sentence in each language. For example, the continuative intonation would be expressed on Anne and the terminal intonation on Eric in the following sentence.

English: I saw Anne but not Eric.

French: J'ai vu Anne mais pas Eric.

German: Du spielst oft mit Anne aber nie mit Erik.

Sentences were typed individually on 12 cm by 20 cm index cards. The speakers while seated in a sound-attenuated chamber read each sentence aloud once. They were instructed to speak with normal intonation at a normal, but relaxed conversational speaking rate. All audio recording for the analysis was carried out with an AKG condenser microphone located approximately 13 cm in front of the speaker's mouth. The microphone output was

amplified by an AMCRON D-75 amplifier prior to being recorded on a Revox B710 audio cassette recorder with Dolby C-type filtering.

Subjects

Three adult males, one French, one German and one English native speaker, read aloud the set of 48 sentences for recording and pitch analysis.

Analysis

The analysis is based on a corpus of 72 sentences (22 French, 24 English and 26 German) with continuative intonation and 65 sentences (21 French, 22 English and 22 German) with terminal intonation. All sentences which sounded natural to the experimenter and which had at least 150 msec of voicing over the word of interest were used in the analysis. The taped sentences were replayed on a Revox B710 audio tape deck and then digitalized using the ILS software package (Signal Technology, 1983) on a VAX 11/730 computer.

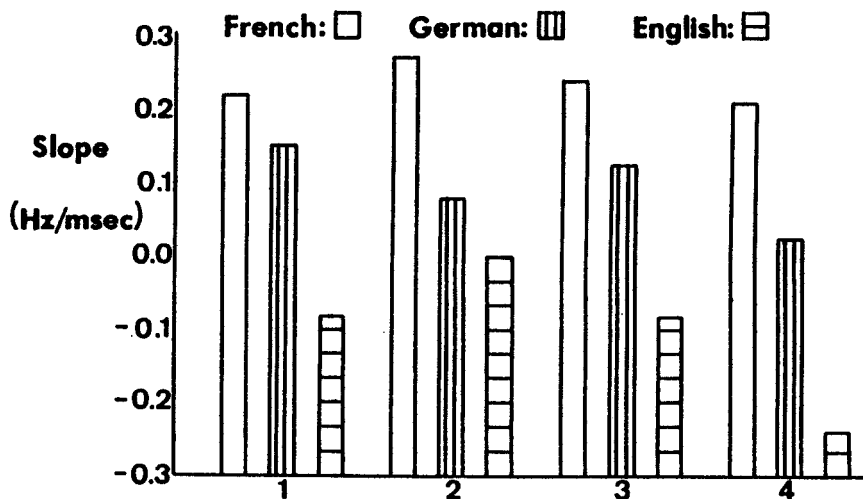
Words with lexical stress in clause- or phrase-final position were analysed using the auto-correlational method with pitch extraction (Signal Technology, 1983). The first and last 10 msec of voicing over the words was not included in the pitch analysis because the pitch algorithm is most reliable over stretches of continuous voicing. The change in F_0 on the clause- and phrase-final words was used to calculate that slope for each sentence pattern for each language. Slope was calculated as the maximum change in F_0 divided by the minimum time (in msec) over which this change in F_0 occurred.

Results

It was assumed that speakers were making any intonational differences on a language-specific basis. The slopes for major continuation differed significantly across all three languages ($X^2(10)=51.5$, $p<.05$). This supports Delattre's claim that the slope of the continuative intonation may distinguish speakers of some languages. The mean continuative slope values for each language were: $-.1$ Hertz/msec for English; $.09$ Hz/msec for German; and $.25$ Hz/msec for French (see Figure 3), where a negative value indicates falling pitch (negative slope), while a positive value indicates rising pitch (positive slope).

Figure 3. The Sentence Patterns Used as a Basis for Eliciting Continuative Intonation in English, French and German.

The slope of F_0 on the word before the conjunction is given for each sentence type in each language.



Sentence Type

- Type: 1. X V X and/or X
 2. X V(X) and V X
 3. X V(X) and then (V) X
 4. X V X but (V) X

Legend: X: Verb, noun phrase, prepositional phrase,
 adverbial phrase or pronoun

V: Main verb

The terminal intonation patterns of the three languages did not differ statistically from each other on the basis of slope. Chi square tests failed to reach or even approach significance on this measure ($\chi^2(10)=10.34, p<.05$). Consequently, only the continuation patterns were used as the foundation for further experiments.

The slope of the pitch was shown to distinguish between the continuative intonations of English, French and German and so was used in further experiments. Whether slope is a significant intonational component in its own right, or whether slope's significance is only an artefact of its dependence on a change in F_0 remains to be established by research addressed specifically to this question.

EXPERIMENT 2

Experiment 1 established that the maximum slope of F_0 in intonation patterns is significantly different for the performance of the same functions, continuation and termination, across English, French and German. Experiment 2 was conducted to see the extent to which speakers impose their native intonation patterns upon their second language. In particular, it was of interest to determine the differences between the intonation of English children learning French in the French immersion programs in Calgary (the immersion students henceforth) and that of monolingual French and English students.

Materials

To elicit sentences with a continuative intonation pattern, five simple two-part pictures were drafted in which a sequence of events was depicted. Immersion students were asked to describe these pictures in French; English and French subjects described them in their native language.

The pictures were designed so that the words occurring under the continuative intonation differed as little as possible in the two languages, thus reducing the likelihood of segmental quality differences causing pitch perturbations which would confound pitch analysis results. Among the most common words analysed were: plante 'plant' and branche 'branch', for example.

Subjects

A total of 83 subjects were obtained from three language groups: English monolingual, French monolingual and immersion students at each of the four age levels: 6 to 7, 10 to 11, 14 to 15 and 16 to 24 years. While we attempted to obtain eight subjects in each age by language group, one group had just four members and one had ten. There were approximately equal numbers of males and females in each age group except in the case of the oldest age group, which contained five males and 14 females.

The monolingual speakers of English and French could speak only their native language. The immersion students were English children who had entered the French immersion programs in the schools at age 5 to 6. These children are taught entirely in French from age 6 to age 11 and they continue to be taught partly in French throughout their school career. At age 15 approximately half of their instruction is still in French. This decreases to a third of their instruction by the end of high school (age 18).

Procedure

Interviews were conducted in English for the English subjects and in French for the French and the immersion students. In half the interviews the cassette was played first, and in half the pictures were presented first. Subjects' descriptions of pictures were recorded using a Song TCM-838 or a General Electric 3-5254A cassette player. The entire interview took less than twenty minutes for each subject.

Analysis

Sentences showing any of the syntactic patterns used in Experiment 1 were accepted for analysis. Sentences were rejected because a) the child used interrogative intonation and waited for the experimenter to indicate that the description was adequate, b) the subject spoke too softly, c) the level of background noise was excessive and d) an immersion subject used English words instead of French ones. Altogether, fewer than 5% of the sentences were rejected. The rejections mean, however, that subjects are represented unequally in the production data. In total, 315 samples were used in the analysis.

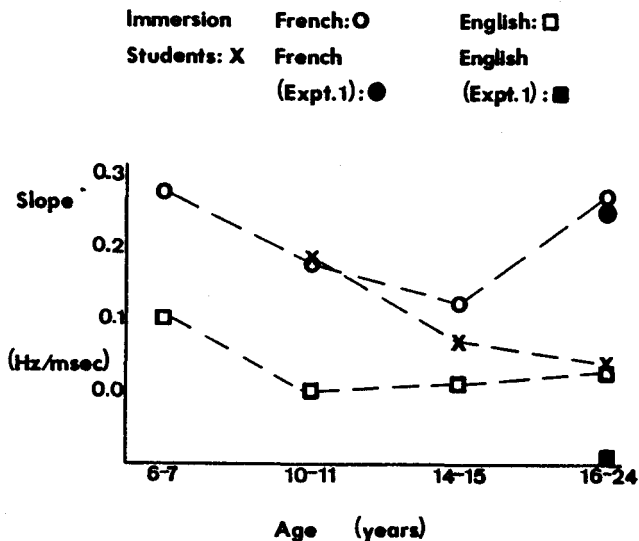
The pitch over the word before a clause or phrase boundary was submitted to a pitch analysis as described for Experiment 1. The values for the maximum slope of $F\theta$ were calculated and then coded according to the subjects' language group, age and sex, and submitted to analyses of variance.

Results

Slopes were more strongly positive for the French and immersion students than for the English ($F(2,312)=13.87, p<.01$). The immersion students did not differ significantly from the native French speakers in the slope of their productions of $F\theta$. While this overall analysis suggests that the non-native speakers do not impose their native intonation patterns upon their second language, more detailed analyses show a more complex pattern. At 10 years, immersion students have an excellent command of the French continuative pattern and are not significantly different from the native French speakers at 10 years. However, with increasing age, the slope of the second language continuative intonation gradually drifts toward English values so that at age 16 the immersion students' French continuative intonation is not

different from the pattern shown by English 16-year-olds (Figure 4).

Figure 4. English, French and Immersion Students' Production of the Slope of F_0 for Continuative Intonation.



Discussion

A number of extra-linguistic factors may account for the apparent deterioration in the performance of the older immersion students. Plann (1977) suggests that native speakers of the culturally dominant language are prone to develop a classroom interlanguage when they become immersed in a less prestigious language, to which they are exposed only in school. She claims that the development and persistence of this interlanguage is due to the large amount of incorrect peer input from classmates and to (adolescent) peer group pressure. While it is possible that an interlanguage (Selinker 1972, Selinker, Swain and Dumas 1975) has developed among the immersion students, there is no precedent for the appearance of second language errors after an error-free acquisition, as is apparently the case here. Production data from young immersion students are needed to show whether any errors at all characterized acquisition before age 10.

Even if an interlanguage has developed, it is not clear whether the older immersion students have lost the ability to produce French continuative slopes, or whether their English

slopes could be classified as temporary errors in performance, rather than competence. This question would require further research.

It is also possible that older students were less often exposed to native French teachers in class and so had less chance to acquire French intonation patterns in the course of their education. The Calgary schools now employ far more native French teachers than was the case even 15 years ago. Also, as immersion students grow older they are offered fewer hours of French per day, although they remain in the immersion program. If this has affected results, then it will be necessary to accept that continued, but reduced, exposure to a second language is insufficient to maintain aspects of it which have already been acquired. It has always been assumed that once a child achieved native-like control of an aspect of his second language, he did not then regress with further exposure to the language. The fact that this appears to happen demands further research into what must be very powerful factors and causes.

A comparison of the results presented here with longitudinal study results from immersion programs offering consistent quality and amount of exposure to French over time is necessary to firmly establish the existence of this apparent deterioration.

The concepts of interference and approximation as used in the literature on second language learning do not appear to be a factor here. The problem is one of apparent deterioration in performance in the acquired second language, and not one of initial acquisition.

EXPERIMENT 3

Experiment 2 showed that the monolingual English and French speakers produced significantly different continuative intonation patterns. Experiment 3 sought to discover whether listeners would decide that their interlocutor was not a native speaker by attending to his intonation. Therefore, it was necessary to have listeners judge speech with native and non-native intonation patterns.

Materials

Two versions of a speech sample were prepared, identical in every respect except intonation pattern. Native speakers were expected to prefer the version with the original, unchanged intonation to the version with the altered intonation.

Eight English, eight French and seven German sentences were selected from the corpus gathered in Experiment 1 to provide a range of slope differences (Table 1). Each French and English sentence was submitted to a pitch analysis and then resynthesized (Signal Technology, 1983).

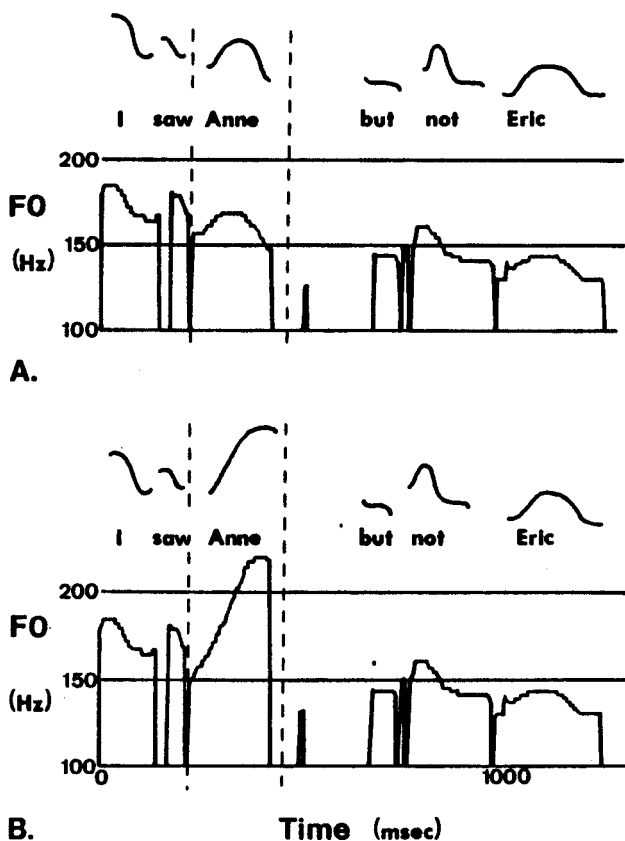
Table 1. Sentences on the Perception Test

Sentence	Slope (original version)	Slope (new)
1. I saw Anne but not Eric.	-0.17	0.39 F
2. The dog chased Marie and frightened Christina.	0.0	0.21 F
3. I played hockey with Karl but didn't enjoy it.	-0.19	0.21 F
4. It was hot in Panama and the insects were ferocious.	-0.08	0.55 F
5. I used to live in Calgary and then I moved to Toronto.	-0.02	0.15 G
6. They saw a film and then they went to dinner.	-0.28	0.08 G
7. I bought a telephone and then I took it home.	-0.17	-0.11 G
8. First they toured Canada and then they visited Alaska.	-0.13	0.10 G
1. J'ai acheté un téléphone puis je l'ai apporté chez moi.	0.13	-0.11 E
2. D'abord ils ont fait le tour du Canada puis ils sont allés en Alaska.	0.41	-0.10 E
3. J'habitais à Calgary mais maintenant j'habite à Toronto.	0.21	-0.01 E
4. Donna aime bien la clarinette mais elle déteste le violon.	0.22	-0.08 E
5. Le chien a chassé Marie et a fait peur à Christine.	0.21	0.15 G
6. Le chien jouait d'abord avec Marie et puis avec Louise.	0.16	0.04 G
7. C'était chaud à Panama et les mouches étaient féroces.	0.53	0.02 G
8. J'ai vu Anne mais pas Eric.	0.35	0.10 G

The pitch was then altered in the analysed versions of these English and French sentences with the help of a pitch modification and transfer program (Esau 1985) in such a way that it assumed a continuative pattern typical of one of the other two languages. For example, in the sentence I saw Anne, but not Eric, the English continuative pattern on Anne was replaced by the French continuative pattern on Anne from the sentence J'ai vu Anne, mais pas Eric (see Figure 5).

Figure 5. Pitch Patterns on Two Versions of the Same Sentence on Perception Test.

(A) shows the original English pitch pattern with a falling continuative slope (between the dotted lines). (B) shows the altered pitch pattern with rising French slope (between the dotted lines).



The sentences which contained these altered F $\emptyset$ values became the 'non-native' sentences, once they too had been resynthesized. There were then two versions, one 'native' and one 'non-native', of each of the eight French and eight English sentences shown in Table 1.

In addition to the eight sentences synthesized without any F $\emptyset$ changes (the 'native' versions), there were four in each language whose intonation had been altered to German values, and four whose intonation had been altered to the values of the other test language (English to French and French to English).

All the synthesized sentences in each language were recorded in pairs onto a Sony UCX-S 90 cassette. Each pair comprised an unchanged and an altered version of the same sentence. Sentences were recorded in two different orders of presentation. Order of presentation within pairs was also varied. To ensure that the synthesized sentences sounded natural, the unchanged versions were played to native speaker judges. Both the English and the French judge said that the quality of the speech was generally excellent, and that the sentences were comprehensible and sounded like the speech of a native.

Procedure

The perception test was recorded onto cassette tape for presentation to the subjects by the experimenter. Responses were recorded on cassette tape as well as manually. On each trial, subjects listened to a pair of sentences and then indicated whether the first or the second sentence in each pair was the more natural example. Immersion students and French speakers heard the eight French pairs, while English speakers heard the eight English pairs. Subjects were allowed to hear a pair of sentences as often as they liked before responding. In half of the interviews pairs of sentences were presented in one order, and in the other half a different order was used. The subjects from Experiment 2 were used.

Analysis

Subjects' judgements were considered to be correct if the sentence selected was the one with unchanged pitch. There were eight judgments from each subject, which were coded according to the subjects' age, language group, sex and the pair type (native language vs. German; and English vs. French or French vs. English) and submitted to an analysis of variance. Newman-Keuls studentized range tests were used to test interesting means.

Results

Neither the French nor the English control subjects discriminated non-native from native sentences at levels beyond chance and there were no main effects for age or language,

sentence type or sex. This means that French groups did no better than the immersion students, who had much less exposure to French than the native French speakers.

The one statistically significant interaction in this data was that the older immersion students identified native continuative intonation more successfully than did the younger immersion students. On the perception test, the 10-year-old, 14-year-old and 16-year-old immersion students all chose the sentences with the French continuative intonation significantly more often than did the 6-year-old immersion students. (For the 10-year-olds, $Q(2,52) = -3.133$; for the 14-year-olds, $Q(2,52) = -3.878$; and for the 16-year-olds, $Q(2,52) = -3.665$.) It is hardly surprising that at age 6 the immersion students did worse on the perception test than did the members of any other group, given that they could not speak French well enough to accomplish the production task.

Discussion

The results indicate that native listeners do not decide that their interlocutor is a non-native speaker by attending to his continuative intonation.

Subjects nonetheless perceive that the differences between the sentences are intonational. Seven out of the eight adult French speakers spontaneously declared after hearing the first two sentences on the perception test that the differences were entirely due to intonation. Numerous English adults pointed out that stress, intonation, tone or emphasis differences between the sentences accounted for their choices. Both native speaker groups said it was extremely hard to prefer one version of a sentence to another, for they could imagine acceptable contexts for both. This means that it is perhaps misleading to speak of a single 'continuative' pattern with respect to perception, as does Delattre (1963).

Although intonation could potentially serve as a cue to non-native speaker identification, it is not a sufficient cue in isolated sentences. A well-defined emotional, social and semantic context for the intonation patterns being investigated might lessen their ambiguity for subjects. This is one possible approach to the problem of convergence of intonational function in intonation patterns.

FOOTNOTES

¹The youngest immersion students (aged 6 years) had only been in the immersion program for one school year. They were unable to understand the instructions in French and so the interview was conducted in English. Their results from the perception test were included in the analysis, but they were unable to produce enough French for the production test and so no production results are available for the 6 year old immersion students.

APPENDIX

The following sentences were used in the first data collection. French and German sentences with similar semantic and syntactic content were used to collect French and German data.

Pattern 1: One verb; continuative intonation measured on the word before 'and/or' in an object clause.

1. The dog's playing with Jane or Anne.
2. She is visiting Anne or Robert.
3. I want the blue dress and the white skirt.
4. I like the flute and the clarinette.
5. I like apples and bananas.
6. Anne goes to school and to church.
7. I play the piano and the clarinette.
8. Paul reads some books and magazines.
9. Mark draws with crayons and pencils.
10. Janice draws with pens and markers.

Pattern 2: Two verbs; continuative intonation measured on the word before 'and'.

11. At night he eats and plays his records.
12. She drinks tea and eats sandwiches.
13. It was hot in Panama and the insects were ferocious.
14. He smashed his guitar and threw it at the audience.
15. The dog chased Marie and frightened Christina.

Pattern 3: Continuative intonation measured on the word before 'and then'.

16. Bob eats lunch and then goes for a walk.
17. Peter goes swimming and then goes home.
18. The kitten plays and then falls asleep.
19. Meg rides her bike and then comes in.
20. She plays and then she goes to sleep.
21. They saw a film and then they went to dinner.
22. I used to live in Calgary and then I moved to Toronto.
23. I bought a telephone and then I took it home.
24. He made a sauce and then poured wine into it.
25. First they toured Canada and then they visited Alaska.
26. The kitten played with Christina and then with Louisa.

Pattern 4: Continuative intonation measured on the word before 'but'.

27. Donna likes the clarinette but she hates the violin.
28. I went out with Anita but came home with Clara.
29. I played hockey with Karl but didn't enjoy it.
30. I danced with Louisa but didn't enjoy it.

31. I sent him a telegram but he hasn't replied to it.
32. Donna gave me her address but I haven't visited her.
33. I saw Eric but didn't talk to him.
34. I saw Anne but not Eric.
35. I spoke to Alice but not to Suzanna.

Terminal Patterns:

36. Jane should send him a telegram.
37. Marie fell into the canal at Panama.
38. She went shopping in Hong Kong.
39. We had steak with some kind of sauce.
40. I don't know his address.
41. I hate bananas and so does Mark.
42. Maria bought a telephone.
43. Yesterday Anne saw a very good film.
44. There aren't many trees in Calgary.
45. The kitten plays.
46. Peter goes swimming.
47. I want the blue dress.
48. The kitten drinks milk.

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