SOLVING A CONTROVERSY IN THE ANALYSIS OF FRENCH RISING PITCH MOVEMENTS

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ABSTRACT

Recent descriptions of French intonation agree that the basic pattern of rising pitch movements can be phonologically analysed as strings of LH melodies. However, they disagree on the number of phonologically contrasting categories that should be identified. The investigation reported in this paper addressed two questions: (1) Can the hypothesis of a three-way phonological contrast between H*H%, H*0% and H*L% be experimentally supported? (2) Can differences in attitude or emotion be detected in phonetically different contours representing phonologically identical intonations? The results of a Categorical Perception experiment, which investigated the question in (1), strongly suggest that the paradigm is unsuited for the investigation of intonational contrasts. A semantic task, administered to answer question (2), suggests that gradiently different F0 variation can be used to signal subtle meaning differences.

1. INTRODUCTION

The phonological analysis of French intonation proposed in Post [1] distinguishes between high rising, rising and rising-falling pitch movements in Intonation Phrase final position. They are transcribed as H*H%, H*0% and H*L%, respectively. The assumption that IP-final rising movements contrast with IP-final rising-falling movements is uncontroversial. There is no such agreement about the phonological analysis of variability in IP-final rising movements.

This paper reports two perception experiments that attempted to find evidence for the proposed three-way phonological distinction. We investigated phonological contrasts by means of the Categorical Perception paradigm as suggested in Gussenhoven [2]. In addition, a semantic task was applied to explore the effect of phonetic differences on the interpretation of tonal categories.

2. IP-FINAL RISING MOVEMENTS IN FRENCH

Three factors have been observed to play a role in the interpretation of fundamental frequency variation in rising movements: (1) the direction of pitch in the final syllable (i.e. high level or rising throughout), (2) the height of the peak in the final syllable, and (3) the timing of the dip - or the starting point - of the final rise. As to the first factor, continuation rises have been claimed to have slightly rising or high level pitch in the final syllable, as opposed to question and exclamation rises, which have rising pitch throughout the final syllable [3]. Also, final rises in questions have been reported to have a higher peak or a greater pitch range than those in continuations [see 4].[1] Delattre and Martin, who distinguish low and high peaks in continuations only, attribute the distinction to the strength of the following prosodic boundary (Continuation mineure versus Continuation majeure [5] and C1 versus C3 [6]).

As to the third factor, Mertens suggests that a late timing of the dip sounds more affirmative than an early timing in continuation contexts (LH versus HH) [7], whereas Auteserre and Di Cristo claim that it plays a role in distinguishing between questions and continuations [8]. However, several findings indicate that the timing of the dip may not in fact be contrastive. Thus, the location of the dip in word-final rises has been reported to be sensitive to the number of syllables that precede the rise [9], and to the duration of the phonemes the rise is associated with [10]. Moreover, speakers have been observed to produce early and late alignments of the dip in identical contexts, in which there was no reason to assume that they were attempting to express a different grammatical function or a difference in attitude [1, 11].

In sum, it is unclear to what extent variability in fundamental frequency is associated with phonological contrasts in French final rises.

3. EXPERIMENT 1: CATEGORICAL PERCEPTION

A well-established method for investigating the existence of categories is the Categorical Perception paradigm (CP) [12]. In this paradigm, subjects perform two tasks. In the identification task, they are asked to identify a stimulus that is taken from an acoustic continuum as a member of one of two categories, situated at the extreme points of the continuum. If the continuum indeed represents two underlyingly different categories, identification should be relatively easy towards the extremes of the continuum, which is reflected as a relatively clear cut-off point in the identification function at which subjects switch from one category to the other. In the discrimination task, subjects are asked to discriminate between pairs of stimuli that are adjacent in the continuum. If perception is categorical, the difference between the stimuli should be easier at the cross-over point between the categories, which will be reflected as a peak in the discrimination function.

Despite objections that have been raised against CP (see [13] for a discussion), the few studies in which it was applied to differences in intonation contours showed promising results [14, 15]. Although discrimination rates were rather low, the peaks corresponded rather closely with the cross-over points in the identification functions. However, the pragmatic use of non-contrastive differences in pitch may obscure CP results, as they might increase the number of perceived differences even though the differences do not function at the phonological level. In order

to distinguish between such phonetic and phonological differences, Gussenhoven [2] suggests that an undoubted categorical and an undoubted gradient difference should be included as experimental baselines to allow for comparisons with the hypothetical category. This is the approach adopted in the present investigation.

3.1. Methods

Five continua, labelled A, B, C, D and E, were created to test the hypotheses that (1) there is a three-way categorical distinction between H*L%, H*0% and H*H%, and (2) variation in timing and pitch direction in IP-final rises is gradient. The continua are depicted in Figure 1.

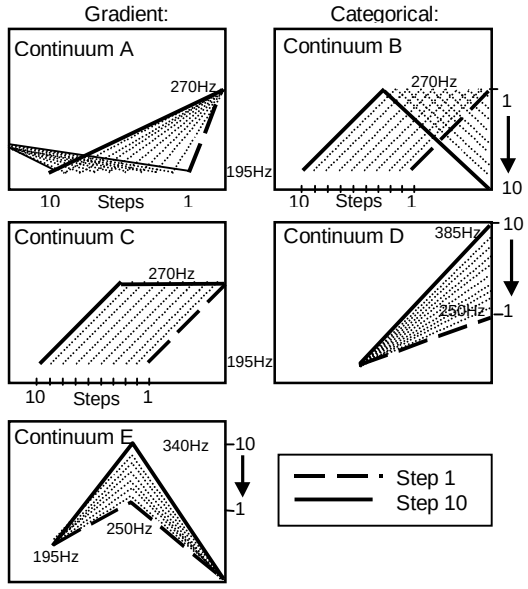


Figure 1: The continua tested in the experiment

The variability shown in A and C in Figure 1 was hypothesised to be gradient, and that in D categorical. The purpose of the B-continuum was to include an uncontroversial contrast in the experiment, i.e. a rising versus a rising-falling movement, and that of continuum E to include an uncontroversial gradiently different continuum.

3.1.1. Materials. Three responses were elicited for each step (or comparison of steps) from each subject. Three utterances were used for the repetitions to increase the variety of the materials: *Mélanie vit normalement* 'Melanie lives normally', *Elle les avale oralement* 'She takes them orally', and *On l'a ému moralement* 'One has moved him morally'. The utterances were recorded in the sound-proof studio of the Arts Faculty of the University of Nijmegen. The female speaker was an academically educated Parisian in her early twenties.

The utterances were digitised at 16kHz and analysed by means of the software package PRAAT 3.8β33. Using the PSOLA technique, the source utterances were resynthesised, changing their overall duration and their fundamental frequency contours to make them as similar as possible. The utterances were given a fundamental frequency contour which was identical for the first four F0 targets (1: onset of voicing, 2 & 4: valleys surrounding the first pitch accent, 3: peak of this accent; they approximated the speaker's original F0 values very closely). The last target coincided with the point in time at which amplitude began to rapidly drop.[2] The stretch of speech following point 4 was the part that was to be manipulated differently in the five conditions.

3.1.2. Subjects and procedure. Eighteen academically trained native speakers from the north of France participated in the experiment. All but one were in their early twenties. No hearing difficulties were reported, and they were paid a small fee.

In the identification task, the five continua were presented separately. Each continuum was introduced by a practice block, in which the subjects were made familiar with extreme ends of the continuum and with the task. The stimuli were randomised, and introduced by an anchor in which the two extremes of the continuum were presented (repeated after 10 stimuli). On the score form, subjects had to give a forced choice response (A or B).

In the discrimination task, subjects were asked to judge the similarity between the members of a pair of stimuli that were immediately adjacent in the continuum (nine comparisons per continuum). A practice session of six stimulus pairs was included to make subjects aware of range of differences they could expect to encounter. A pilot test in which stimulus pairs were presented in the AX format showed that the number of perceived contrasts was very low. We therefore decided to immediately repeat the stimulus pair in the reverse order, as this made the contrast between adjacent steps more salient. The subjects were asked to cross the box labelled *différent* 'different' whenever they thought they perceived a difference at any time during the presentation of the stimulus pair. On the test tape, the order of presentation of the stimuli pairs was completely random.

In both tasks, half of the subjects listened to the reverse order of the stimuli (and of the continua, in the identification task) to control for order effects. The DAT-tapes were presented over headphones in a quiet room.

3.2. Results

The results from the identification task are shown in Figure 2, as the percentage of times subjects identified a stimulus as step 10. Only continuum D shows a relatively sharp cross-over point, but in continua A, B, C and E steps 1 and 10, the extremes of the continua, are not always correctly identified. In continuum B, which represents the undoubted phonological contrast, identification does not indicate categorical perception. A statistical analysis, which compared every identification function with every other function, revealed that all were significantly different, except for those of continua C and E (t-tests, $p<0.01$). That is, only the shapes of the curves for continua C and E do not differ significantly.

The discrimination data in Figure 2 show that discrimination is very poor in all continua. In continua A, B, C and E it is

mostly well below chance level, and there are no clear discrimination peaks in any of the continua. A repeated measures analysis of variance [16], performed for each continuum separately with the factor PAIR (9), revealed significant differences for continua C, D and E (Huyn-Feldt corrected F for C: F[1,7.1]=3.405, $p<0.01$; for D: F[1,7.1]=6.159, $p<0.001$; and for E: F[1,7.5]=3.006, $p<0.01$). However, as none of the observed discrimination peaks coincided with the cross-over point in identification, the discrimination and identification functions cannot be assumed to be related.

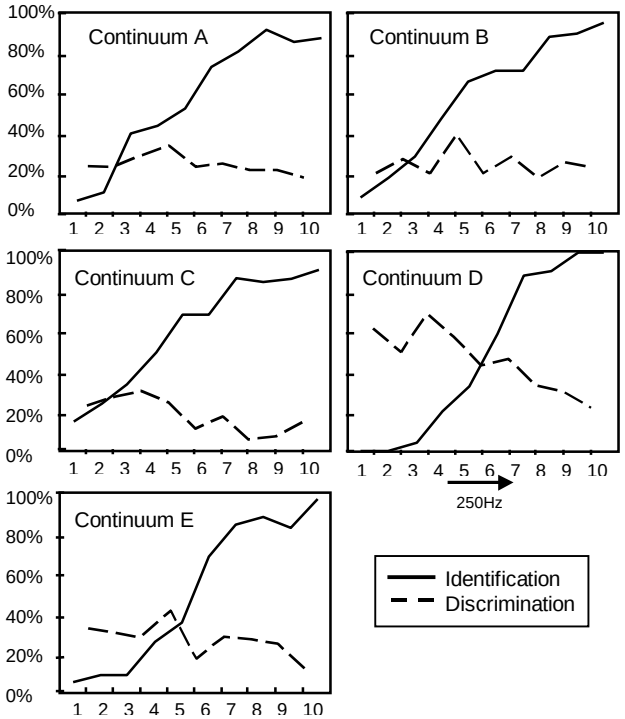


Figure 2: Identification and discrimination results in the five continua

3.3. Discussion

The Categorical Perception data do not enable us to confirm our hypotheses. Nevertheless, the better identification performance in continuum D could be interpreted as an indication that variability in peak height in final rises is likely to be categorical.

The poor results indicate either that the CP paradigm was not applied correctly, or that the intonational contrasts investigated are not in fact perceived categorically. Although the presentation of the stimuli in the discrimination task was unconventional (ABBA instead of AX, ABX or 4IAX), and may therefore have obscured our findings, the overall very poor results of the identification task support this view. The absence of clear results for continuum B, which represented the known phonological contrast, strongly suggests that CP may not be suitable to investigate our hypotheses.

4. EXPERIMENT 2: SEMANTIC JUDGEMENTS

In the second experiment, a semantic task was applied to a subset of the stimuli that were used in the first experiment. The aims of the experiment were (1) to investigate whether gradual variation, which does not function contrastively at the phonological level, can affect the attitudinal or emotional interpretation of the tonal morpheme, and (2) to establish the nature of these effects. For instance, the timing of the dip in the final rise – which is phonologically non-contrastive in the phonological analysis assumed here – may be found to lead to gradiently different interpretations. Thus, an earlier timing in a question rise might, for instance, increase the likelihood of a surprised interpretation. This would imply that phonetic implementation can be governed by and used for the signalling of pragmatic interpretation.

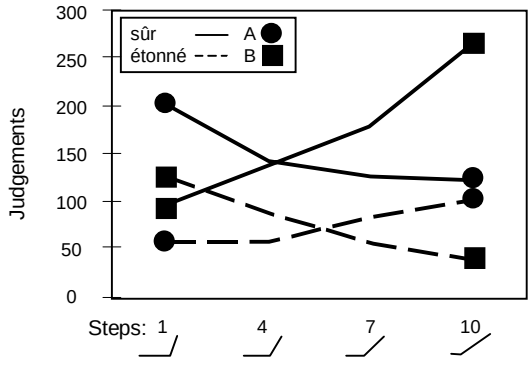
4.1. Methods

The influence of the variability in F0 was investigated in continuum A (dip timing) and B (contrast between rising and rising-falling movements) by means of contrastive judgements of attitudinal meanings. With the help of a native speaker, *étonné* 'surprised' and *sûr* 'certain' were chosen from a number of attributes, because they were most likely to reveal interesting differences between the continua. Four steps (1, 4, 7 and 10) were selected to create 16 stimulus pairs in each continuum. Each step was combined with every other step in both directions (AB and BA), and with itself (AA). Since a pilot experiment showed that subjects objected to giving forced choice responses (as identical pairs had been included), we decided to add a third response category 'identical'. Subjects were instructed never to use this option when they thought they heard a difference between the stimuli.

The stimulus pairs were randomised such that the same pair appeared maximally twice in succession. First, subjects had to indicate for each pair in which stimulus the speaker sounded more sure of herself. Then, they listened to the same pairs again to assess the speaker's surprise. A second order of presentation was created in which the semantic scales and the stimulus pairs were reversed, which was played to the other half of the subjects (as in the first experiment).

4.2. Results

On each continuum, the attitudinal meanings were found to have the reverse effect. Figure 3 gives the pooled scores for the semantic judgements.



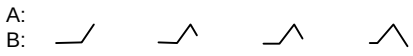


Figure 3: Contrastive judgements of 'assured' and 'surprised' for continua A and B

The data points represent the number of times that the stimulus was judged to sound more surprised or more assured in the stimulus pair. The figure shows that an earlier timing of the dip in final rises sounds more surprised and less assured (continuum A). A stronger effect can be observed in continuum B, where a greater fall signals less surprise and more security. Scheffé's method was used to analyse the data.[3] The analysis provided a yardstick with which the distance between the steps could be measured. It revealed that in continuum A, only steps 1 and 10 were significantly different at the five percent level for *sûr*, and for *étonné* that between steps 1 and 7, 1 and 10, 4 and 7, and 4 and 10. In continuum B, all steps were significantly different at the five percent level for *sûr*, and steps 1 and 7, 1 and 10, 4 and 10, and 7 and 10 for *étonné*.

4.3. Discussion

A possible explanation of these findings is provided by Ohala [17], who discusses similarities in the 'affective' use of F0 variation in the languages of the world. He suggests that low and/or falling F0 tends to signal assertiveness, authority and confidence, hence its frequent use in assertions, whereas high and/or rising F0 signals deference, politeness and lack of confidence, and often marks questions. Our finding that rising-falling movements sound more assured and less surprised than rising movements appears to reflect this functional difference. Also, the finding that an earlier timing of the dip, where higher pitch can be perceived for a longer period of time, sounded less assured and more surprised could be interpreted to corroborate Auteserre and Di Cristo's claim that early rises tend to be used in questions, and late rises in continuations [8].

5. CONCLUSION

Despite the introduction of undoubted contrastive and gradual variability in the continua of the Categorical Perception experiment, a meaningful evaluation of our hypotheses about the gradience of F0 variability in final rises could not be made on the basis of the identification and discrimination functions. The poor results for the phonological contrast between rising and rising-falling pitch movements may be interpreted to indicate that the differences were perceived continuously. Also, the similarity of the results for continua B and E suggests that differences in pitch may be more easily detectable than differences in timing. If so, the subjects' performance in continua D and E may be the result of auditory processing instead of categorisation in speech. These findings raise the question whether categorical perception is a prerequisite for phonological category membership in intonation. This means that an imitation task may be applied more successfully in the investigation of intonation categories (see [2] for a discussion).

The findings of the semantic task establish that variation in the timing of a rise has an effect on the interpretation of the utterance. Unfortunately, they do not allow us to draw any conclusions about the grammatical level at which this variation should be described. Yet, the fact that the effects were overall stronger for the continuum with the well-established contrast (B) than for the putatively gradient continuum (A) would be accounted for in a phonological model that distinguishes between phonetic variation, which can serve to convey subtle meaning differences, and contrastive variation, which should be accounted for at the phonological level of the grammar.

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NOTES

1. Faure claims that the exclamation rises also have higher pitch peaks [3].
2. Initially, point 5 was placed at the offset of voicing, but as a result, pitch predictably sounded lower towards the end of the utterance-final accented syllable in some steps of some of the conditions.
3. As subjects only had the choice between 3 scoring categories, it is unclear whether the assumptions of Scheffé's method (scores on a rating scale with minimally 7 points) are met.

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