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Caspers, J.; Trouvain J., Barry W.J.

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INVESTIGATING THE RELATIONSHIP BETWEEN HIGH, LOW AND LEVEL CONTOUR ENDINGS AND PUNCTUATION SYMBOLS IN DUTCH

Johanneke Caspers

Dept. of Dutch Studies/Leiden University Centre for Linguistics
j.caspers@let.leidenuniv.nl

ABSTRACT

A phonological distinction can be made between two different final boundary tone types in Dutch: high (H%) and low (L%). A third possibility is for an intonation contour to end without an H% or L% tone, resulting in a 'level' ending (%). As yet it is not completely clear what these melodic differences signify to the listener, and the present perception test aims to find out more about the interpretation of these differences. In a listening experiment declarative sentences with different intonation contours were presented to native listeners, who had to indicate whether they thought the stimulus ended in a comma, a full stop or a question mark. Results are clear for L% tones (full stop) and for level ending contours (mainly commas, no question marks). Within the category of H% tones the higher ending rises lead to more question responses, while the lower ending rises prompt more comma responses.

Keywords: prosody, intonation, boundary tones

1. INTRODUCTION

1.1. ToDI

ToDI (**T**ranscription **o**f **D**utch **I**ntonation, [4]) distinguishes two types of final boundary tone: a high one (labeled H%) and a low one (labeled L%). The H% tone, which is realized as a pitch rise on the final syllable of an Intonational Phrase (IP), may function as a question mark, but it can also signal that there is more to come (nonfinality, cf. [3]). Furthermore, there is evidence from perception experiments that H% can be interpreted as question marker as well as 'comma' intonation [1]. This means that the H% tone seems ambiguous with respect to turn-taking, the alternation of speaking turns in conversation.

The low boundary tone (L%), realized as a low point at the end of an IP, seems to simply mark a unit as finished.

The absence of a high or low boundary tone at the end of an IP is labeled '%' in the ToDI system: the speech melody does not rise at this point, nor does it fall to low, it remains somewhere 'in the middle', which gives a typically unfinished impression. Caspers [2] reports a clear relationship between turn-holding and level ending contours (%) for a corpus of Dutch dialogues, while no such relationship was found for the low (L%) and high (H%) boundary tones and turn-taking. This suggests that only the absence of a high or low boundary tone is an unambiguous cue in the turn-taking system (viz., 'this unit is unfinished, there is more to come'). The function of the L% and H% tones in the turn-taking system is less straightforward. If these tones are relevant to turn-taking, it has to be in a more complex way.

1.2. Phonetic vs. phonological contrast

Perception experiments by Remijsen en Van Heuven ([8], [9]) showed that the phonological difference between L% and H% boundary tones is categorical in nature: above the L% tone there is – linguistically speaking – a single category of non-low boundary tone. From the results of a perception study on German (a language closely related to Dutch) with a setup comparable to [8], it was concluded that there are not two but three categories of boundary tones: L% is always terminal, but non-low boundary tones can either be terminal (question) or non-terminal [10]. Production data for Swabian German show that %-contours occur more often with sentence continuation and H%-contours with lists and yes-no questions [7:96]. Furthermore, there is evidence for a continuum between a 'continuation' and a 'question' interpretation within the category of H% tones in Dutch: the higher the tone, the more likely a question interpretation is [6]. This means that the phonetic implementation of the H% boundary tone influences the perceived function of this tone (i.e., as comma or question mark).

1.3. Research question and approach

The current question is what the three different contour endings signal to the listener when they are presented on a declarative sentence: finality, continuation or interrogativity. The L% tone is expected to signal finality ('this unit is finished'), and % to signal continuation ('this unit is incomplete', cf. [1], [2], [4]). The H% tone is expected to signal interrogativity ('please answer') predominantly. As it is conceivable that the position of the H% tone within the pitch register is relevant for the distinction between a continuative and an interrogative interpretation, the influence of preceding pitch accent type and height of the final rise is investigated as well.

It was decided to use punctuation symbols as response category since there is a direct correspondence with the categories finality (full stop), continuation (comma) and interrogativity (question mark), and since everyone is familiar with these symbols.

The stimulus materials consist of synthesized utterances with automatically generated ToDI contours.

1.4. Stimulus contours

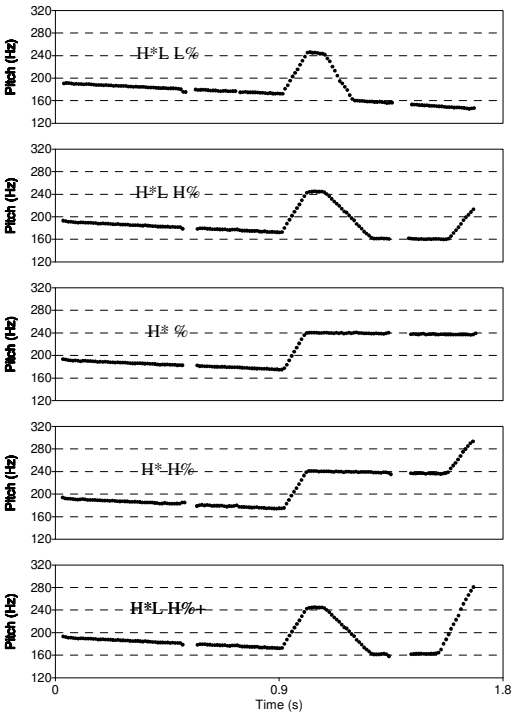
Four melodic configurations were investigated: H*L L%, H*L H%, H* % and H* H% (ToDI notation). In a corpus of Dutch dialogues, these were the most frequently used contour types containing an H* nuclear pitch accent [2]. As a fifth melodic configuration a variation on the standard H*L H% contour was added, ending in an extra high rise (H%$^{+}$). The five contours are illustrated in figure 1. They were synthesized on four different short declarative sentences (eight to ten syllables), using a female voice.

The first contour in figure 1 represents the default 'pointed hat' pitch accent (H*L) followed by a final low tone (L%). The third contour consists of a rising pitch accent (H*) followed by a stretch of level pitch up to the end of the utterance (%). The remaining three contours all end in an H% tone, but in the H*L H% contour the final rise starts at the low declination line, while the final rise in the H* H% contour has its starting point at a much higher level. Furthermore, the endpoint of the final rises varies: from moderately high in the H*L H% contour to very high in the H* H% and H*L H%$^{+}$ contours.

1.5. Subjects and procedure

Twenty six native speakers of Dutch participated in the experiment; they were paid a small fee. Eighteen were female and their ages varied between 18 and 39. Subjects listened to the stimuli at a comfortable loudness over Quad ESL-63 electrostatic loudspeakers, while seated in a sound-treated lecture room. They had to select the best fitting punctuation symbol for each stimulus and marked their responses on printed answer sheets.

Figure 1: Examples of the intonation contours used in the experiment.



2. RESULTS

The results for the three types of contour endings are presented in table 1 (for more details see additional text file 1).

Table 1: Absolute (and relative) frequency of full stop, comma and question responses per melodic boundary type.

melodic boundary type	full stop	comma	question	total
L%	191 (92%)	17 (8%)	-	208
%	71 (34%)	124 (60%)	13 (6%)	208
H%	76 (12%)	272 (44%)	276 (44%)	624
total	338 (33%)	413 (40%)	289 (28%)	1040

As is clear from the table, the predictions were correct with respect to the L% boundary tone: subjects think the utterance is finished in 92% of the cases. When the stimuli end in a level contour (%), however, the predicted comma response occurs in only 60% of the cases; in a third of the cases subjects unexpectedly respond with a full stop. This finding may be attributed to the fact that the H* % contour sounds a little less natural than the other contours (probably as a result of the relatively long stretch of high level pitch; this problem was acknowledged when the stimuli were created, but it could not be solved within the ToDI synthesis facility).

With respect to the contours ending in an H% boundary tone, question responses were given in only 44% of the cases, while a majority of question mark responses was expected. A comma was responded in the same proportion of cases (44%). Whether there was any difference between the three contour types ending in H% tones can be derived from the following table:

Table 2: Absolute (and relative) frequency of full stop, comma and question responses for the three contour types ending in H%.

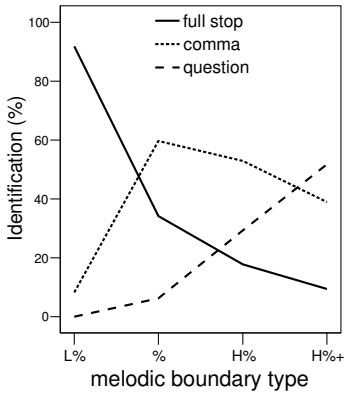
contour	full stop	comma	question	total
H*L H%	37 (18%)	110 (53%)	61 (29%)	208
H* H%	17 (8%)	87 (42%)	104 (50%)	208
H*L H%$^+$	22 (11%)	75 (36%)	111 (53%)	298
total	76 (12%)	272 (44%)	276 (44%)	624

Within the category of H% boundary tones, relatively large differences do indeed appear: the contour ending lowest in the pitch range (i.e., H*L H%, see figure 1) leads to the largest proportion of comma responses (53%), while the two high-ending contours evoke more question responses (50-53%). However, the response to the two higher boundary tones is not overwhelmingly interrogative, indicating that even these contours are not regarded as prototypical question contours, at least not in the current setting.

What the data do show is a clear effect of the final height of the high boundary tone on the proportion of comma and question responses, in the sense that higher rising tones lead to more question responses. This indicates that the endpoint of the H% boundary tone is indeed relevant to its perceived function (cf. [6]). The phonological identity of the pitch accent immediately preceding the boundary tone (i.e., H*L versus H* in the current experiment) does not seem to matter for the perceived function of the contour in terms of punctuation, since the H* H% and H*L H%$^+$ contours receive virtually identical responses (a post-hoc analysis presents these two contours as one group). This means that it does not matter whether the final rise starts at the low or high declination line (cf. figure 1); only the endpoint of the rise seems relevant for its interpretation.

Collapsing the statistically identical H* H% and H*L H%$^+$ contours (into a single category of high-ending tones, labelled H%$^+$), figure 2 presents the percentages of full stop, comma and question responses for the four remaining categories of end tone.

Figure 2: Percentage of full stop, comma and question responses for the different melodic boundary types.



The figure suggests a clear trend for the number of full stop responses to diminish while the height of the final tone increases, and for the question responses to increase with the height of the final tone. In fact, this is not exactly the case, because the %-ending lies in between the H%- and H%$^+$-endings within the pitch register, and not below them (cf. figure 1). Furthermore, it cannot only be the final height of the contour that is relevant to its function, since the level contour ends fairly high, but prompts virtually no question responses. It is probably the level character of the %-contour that makes it unsuitable as a question marker.

Post hoc analyses on the percentages of full stop, comma and question mark responses show the following groups:

full stop: L% — % — H% — H%$^+$
comma: L% — % | H% — H%$^+$
question: L% | % — H% — H%$^+$

With respect to the full stop responses, the four boundary types form statistically separate categories. With respect to comma intonation, the distinction between level and moderately high contour endings is not relevant, which means that that these contours bring about roughly the same amount of comma responses. Within the category of rising final tones the higher tones prompt significantly more question responses than the lower ending ones, but there is no difference between the L%- and %-ending contours. This suggests that the level contour is as 'non-questioning' as the low final tone.

3. CONCLUSION AND DISCUSSION

Clearly there is no one-to-one correspondence between the three phonologically different contour endings in Dutch and the three punctuation symbols used as possible response classes.

For the low tone (L%) the results are clearest: 92% full stop responses, supporting the view that this tone - unambiguously - marks a unit as complete. For the level ending contours (%), which were expected to prompt comma responses predominantly, the results are less clear, but counting the unnaturalness of this specific contour type in the stimulus materials, the 60% comma responses constitute some support for the view that this contour marks a unit as unfinished. Note that the contour is *not* identified as a question marker, confirming the results of [1].

The results for the H% tone are the most complex. Instead of the expected preference for question mark responses, the results show systematic effects of the height of the H% within the pitch register: the lower ending final rises lead to relatively more comma responses and the higher ending rises to more question responses. However, the percentage of question responses to the higher ending contours does not exceed 53%. It could have been the case that the highest end tone used in the stimulus materials simply was not high enough, but it could also be that all H% tones always allow a comma interpretation. In addition, the syntactic form of the sentences used in the experiment may have played a crucial role: declaratives could be harder to interpret as questions than the sentences used by [6], whose syntactic make-up allowed only an interrogative or an imperative interpretation. Production research of different types of questions in Dutch revealed that declarative questions always end in final rises, in contrast to wh and yes-no questions, and that they are realized on a higher pitch register [5]. This means that it is very likely that there was a bias towards full stop and comma responses in the present dataset.

The current data suggest that it is not simply the height of the endpoint of the intonation contour that is relevant to its function in terms of punctuation symbols. The stimuli ending in level contours (%) have an endpoint that lies below the endpoint of higher rising final tones (H%$^+$, see figure 1), but above the endpoint of the lower rising final tone (H%), while the punctuation scores do not reflect this medial position. Instead, responses to the %-contours suggest that they form a separate phonological class. This could be due to the fact that % is not a movement confined to the last syllable, as is the H% tone; instead the contour ends in a stretch of more or less level mid high pitch, starting at the peak of the final pitch accent (H*) and ending at the utterance boundary. The precise influence of the height of the final rise in different interactive situations should be investigated further.

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