# Fundamental Frequency in Feedback Words in Swedish

Tronnier, Mechtild; Allwood, Jens

*Published in:*
ICA 2004

2004

*Document Version:*
Publisher's PDF, also known as Version of record

# Fundamental frequency in feedback words in Swedish

*Mechtild Tronnier[1] and Jens Allwood[2]*

[1]Dept. of Language and Culture, Linköping University, Sweden
[2]Dept. of Linguistics, Göteborg University, Sweden
mectr@isk.liu.se

## Abstract

Two investigations of the fundamental frequency in Swedish feedback words are presented. The hypothesis that F0-patterns differ systematically for words signalling positive and negative feedback-i.e. agreement and disagreement with the utterance of the preceding speaker-cannot be confirmed from the investigated data of spontaneous dialogue in Swedish. Furthermore an identification test shows that it is difficult for native speakers of Swedish to differentiate between positive and negative feedback words when presented solely by their fundamental frequency. However, some fundamental frequency patterns are preferred over others to be representative for positive or negative feedback.

## 1. Introduction

When imitating the intonation of agreement vs. disagreement in Swedish discourse, the negative feedback word *nej* 'no', mostly in utterance initial position, is often produced with a falling F0 stretching over a larger frequency range. On the other hand, the positive feedback word *ja* 'yes' is produced partly with a steady intonation, shifting into a rise. There is some variation, which may be based on the interlocutor's degree of involvement in the topic, the degree of formality of the context among other factors. The Swedish system for linguistic feedback has been described in [1] and [2].

Below, two investigations are presented. The first concerns to what extent the F0-contours introduced above are used in naturalistic dialogues and if other F0 contours representative of positive or negative feedback can be found. The second concerns the identification of positive or negative feedback when represented by fundamental frequency alone.

Earlier studies on prosody of feedback have mainly focussed on feedback in speech acts, such as overlapping back-channelling [3]. In some of those investigations only conditions without turn-taking of the responding part were included [4]. In the presented investigations we concentrate on prosody in feedback words-introductory to a new turn taken by the interlocutor.

The data used for both investigations originates from naturalistic dialogues which are part of the Göteborg Spoken Language Corpus (GSLC) [6]. For that reason 40 parts of dialogues were extracted. They are of the structure that a speaker starts off with a declarative utterance to which the interlocutor responds with agreement or disagreement in the form of a phrase introduced by a positive or negative Swedish feedback word. The Swedish feedback words *ja* 'yes' and *nej* 'no' both contain voiced segments only. Examples are given below, with the feedback words underlined:

- Speaker 1:
  *Det är alltid roligt att komma hem efter semestern.*
  'It's always nice to come home after the holidays.'
- Speaker 2, positive feedback:
  *Ja, det är sant.*
  'Yes, that's true.'
- Speaker 2, negative feedback:
  *Nej, den borde vara för alltid.*
  'No, it should last forever.'

Dialogues which contained a negation in the initial utterance followed by a response introduced with *nej* 'no' were not included, since they mostly signal agreement. Furthermore, our data did not include responses to questions.

## 2. Feedback F0 in spoken dialogues

The first investigation focuses on the production of fundamental frequency contours with positive and negative feedback words. The data consists of 40 feedback words, seven produced with negative feedback and 33 with positive feedback. This reflects that there is much more positive then negative feedback in GSLC. For a positive feedback word the contour hypothesized to be typical consisted of a static part followed by a rise, whereas a negative feedback word was hypothesized to typically embody a fall of the fundamental frequency. Furthermore other F0-contours, which were relatively common in the data were also taken into account.

The number of occurrences of each contour was counted and the distribution across their use with positive and negative feedback words was examined. Word length and frequency range or slope were also taken into consideration.

The analysis of fundamental frequency was carried out in the speech analysis program PRAAT.

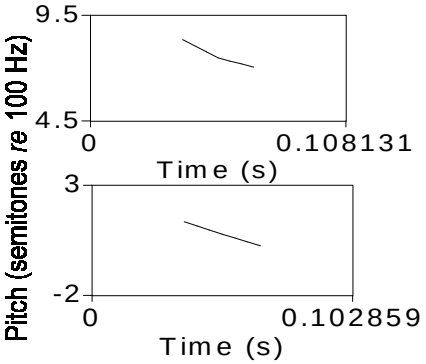


*Figure 1*: Examples of the falling F0 (2.1.) originating from the positive feedback word *ja* (upper) and from the negative feedback word *nej* (lower).

### 2.1. Falling F0

This contour occurred in nine cases, in two cases together with a negative feedback word and in seven cases with a positive feedback word. Examples of a falling F0 contour produced with a positive and a negative feedback word are presented in Fig. 1.

The length of the feedback words varied between 81ms and 462ms and the declining slope varied between $1.1^{st}$/s and $2.4^{st}$/s ($^{st}$/s = semitones per second). Relatively long feedback words often contained some creaky voice.

Since the general occurrence varied between positive and negative feedback words, the relative occurrence of this particular contour does not vary between the two feedback categories (27% for positive, 28% for negative). This implies that this contour does not advocate agreement or disagreement with the previous speaker's declarative utterance.

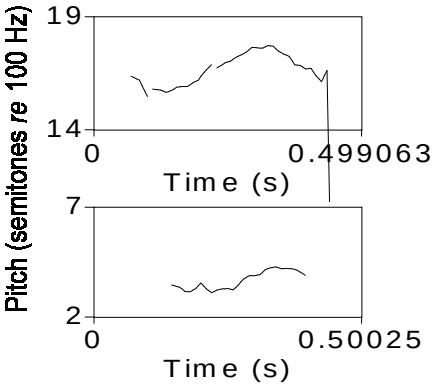


*Figure 2*: Examples of the contour steady F0 with rise (2.2) originating from the positive feedback word *ja* (upper) and from the negative feedback word *nej* (lower).

### 2.2. Steady F0 followed by a rise

This contour occurred in seven cases, in one case together with a negative feedback word and in six cases with a positive feedback word. Examples of the contour produced with a steady F0 followed by a rise together with a positive and a negative word are presented in Fig.2.

The relative occurrence of this particular contour does not vary very much between the two feedback categories (18% for positive, 14% for negative).

### 2.3. Other recurrent F0-contours

#### *2.3.1. Rising F0*

This contour occurred in seven cases, in three cases together with a negative feedback word and in four cases with a positive feedback word. Word length varied between 76ms and 502ms and the rising slope varied between $0.4^{st}$/s and $2.9^{st}$/s.

This particular contour was relatively more frequent with a negative feedback word (43%) than with a positive feedback word (11%).

#### *2.3.2. Oscillating F0*

This contour occurred in six cases and in all cases together with a positive feedback word. Word length varied between 368ms and 639ms and the oscillation range deviated between 1.6st and 2.6st from the baseline.

#### *2.3.3. Fall and rise*

This contour occurred in four cases and in all cases together with a positive feedback word. Word length varied between 258ms and 458ms. In all cases the initial fall had nearly the same length as the rise. The F0-range of the fall varied around 3.0st, whereas the F0-range of the rise varied between 1.4st and 3.7st.

### 2.4. Discussion

It has been shown above that the particular F0-contours hypothesised to represent positive and negative feedback were produced together with either type of feedback. Furthermore even more detailed factors like temporal alteration of the performed F0-contour, which might result in a different slope of a fall, showed comparable similarity for the two categories. That could mean that other aspects than agreement or disagreement with the preceding speaker's utterance are denoted when those particular contours are used. Such aspects could include the speaker's attitude and emotions, but also the structuring of an utterance or information unit by e.g. giving focus to the feedback word.

Other contours also evolved. One of them was used for both feedback categories as well (rising F0),

whereas other contours represented positive feedback consistently (Oscillating F0 and Fall-Rise). To what extent the latter contours are typical of agreement with the preceding speaker's utterance will be taken up in more detail in the following section.

## 3. Identification of feedback words

In this section the identification of Swedish feedback words as being positive or negative based on information only about their fundamental frequency is investigated. More precisely, an examination of the following questions was carried out:

- Do listeners identify feedback words correctly when solely presented by their fundamental frequency?
- If not, are there any contours which listeners prefer to represent positive or negative feedback?
- Are there any contours which listeners are indifferent to?

The material used in the preceding investigation was also used for the identification test. The tokens, which consisted of seven negative and 33 positive feedback words, were manipulated in the speech analysis program PRAAT in that they were transferred into a hummed signal preserving the original fundamental frequency. No spectral information about the supraglottal part of the vocal tract was present in the derived signal, however information about the glottal status was maintained, e.g. creaky voice.

These hummed F0-contours were randomised and presented to 15 listeners. They all have Swedish as their first language and work with language in different ways, but none of them is a trained phonetician. They represent a variety of – merely southern – Swedish dialects. They could listen to the stimuli as often as they wished – but were usually content with two repetitions – and had to decide in a forced choice test, whether they heard a positive or a negative feedback word. The listeners were informed that the number of positive and negative feedback words was not evenly balanced, but the exact ratio was not given. Each stimulus occurred only once in the whole test.

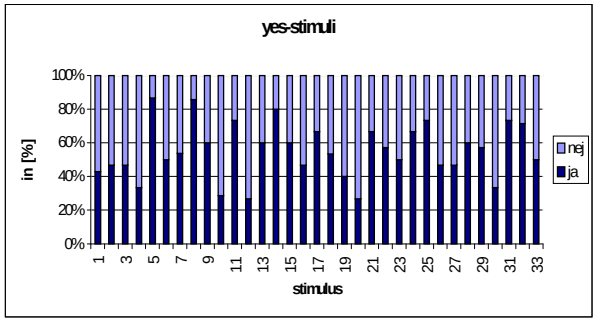


*Figure 3:* Results of correct identification of the positive feedback word in [%].

### 3.1. Results and discussion: identification

As can be seen in Fig. 3 and Fig. 4 none of the stimuli is correctly identified by all listeners. However, neither is any stimulus judged to belong to the contrasting feedback category by everyone. The highest correct identification rate is 86% for positive feedback (Fig.3, stimulus 5) and 80% for negative feedback (Fig.4, stimulus 4). The lowest rate of correct identification is 26% for positive feedback (Fig.3, stimuli 13 and 20) and 13% for negative feedback (Fig.4, stimulus 2).

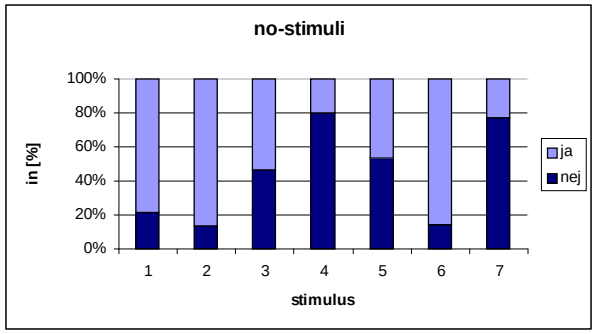


*Figure 4:* Results of correct identification of the negative feedback word in [%].

Among those stimuli judged to be positive feedback words with more then 70% agreement between the listeners seven stimuli originated from positive feedback words (Fig.3, stimuli 5, 8, 11, 14, 25, 31 and 32) and three stimuli originated from negative feedback words (Fig.4, stimuli 1, 2 and 6). Stimuli judged to be negative feedback words with more than 70% agreement correspond to stimuli originating from negative feedback words in two cases (Fig.4, stimuli 4 and 7) and from positive feedback words in three cases (Fig.3, stimuli 10,12 and 20).

For the majority of stimuli (25 cases) no agreement between the listeners in assignment to positive or negative feedback is found: 31-69% agreement for each category.

The stimuli correctly judged to originate from a positive feedback word with over 70% agreement (Fig.3) display a range of F0-contours. The same is true for the two negative stimuli correctly judged with over 70% agreement (Fig.4). More detail is presented in 3.2.

### 3.2. Results and discussion: preference

Do the stimuli highly favoured for positive or negative feedback (over 70% agreement) have anything in common, regardless of their origin?

The F0-contours found to be favoured for positive feedback words can be divided as follows:

- Falling F0 occurred in four cases, two of which originated from a negative feedback word and two from a positive feedback word.

- Rising F0 occurred in three cases, two of which originated from a positive feedback word and one from a negative feedback word.
- Steady F0 with final rise occurred twice originating from positive feedback words.
- Steady F0 occurred once originating from a positive feedback word.

The F0-contours favoured for negative feedback words are the following:

- Steady F0 with final rise occurred once originating from a negative feedback word.
- A slight rise followed by a slightly oscillating F0 at a lower frequency level, a contour which is clearly structured into two parts, occurred once originating from a negative feedback word.
- The oscillating F0-contour (cf. *2.3.2.*) occurred three times, originating from positive feedback words.

It can be seen that there is quite some contour variation leading to a stimulus assignment representing positive and negative feedback. Interestingly, the falling F0-contour-hypothesised to represent a negative feedback word-is favoured for a positive one. Also the rising F0-contour (cf. *2.3.1.*) is preferred for positive feedback.

The F0-contour hypothesised to represent positive feedback (cf. 2.2.) is chosen to be representative of both positive and negative feedback. A contour representative of perceived negative feedback is the oscillating F0-contour, which is only produced with positive feedback words.

In summary, elementary F0-contours like rises and falls are preferred for positive feedback words. This is not quite as clear for negative feedback words, where more complex F0-contours were given priority.

### 3.3. Results and discussion: indifference

There is not much agreement among the listeners which category the majority of stimuli belongs to (30-70% positive or negative judgement). Most of those stimuli are partly produced with some creaky voice, which obviously obscures identification and assignment. Otherwise those stimuli often have in common that they are relatively long (over 400ms in many cases). Many of them consist of the oscillating contour type presented in 2.3.2.

Long duration of a feedback word seems to limit the assignment ability even together with other contour types, e.g. long rises and long falls or combinations. Hesitation may be signalled, which in general weakens the expressiveness of agreement or disagreement otherwise lexicalised by a feedback word.

## 4. Summary and conclusions

The F0-contours vary in their shape-although not systematically-to denote positive and negative feedback words extracted from Swedish feedback phrases. Identification of positive and negative feedback words based on fundamental frequency is quite poor. Clear F0-contours without internal alteration are preferred for a positive feedback word, whereas more variable F0-contours are assigned to negative feedback words. Long F0-contours, often containing some creaky voice and a more complex F0-pattern, cause difficulties for assignment.

The F0-contours in positive and negative feedback words contain more information than solely feedback information. Furthermore, they do not contain enough information to be identified as negative or positive feedback. This raises the question if information whether feedback is negative or positive can be found in a broader scope of prosody, like phrasal prosody, including intonation and pausing. Another question is to what extent the fundamental frequency is an information carrier on the whole. One might assume that in some cases-such as noticeable hesitation-information about the feedback type is solely conveyed by the words.

## 5. Acknowledgements

This work has been supported by a NorFa grant (Nordisk Forskerutdanningsakademi) to the projects NORDTALK and SWEDANE.

## 6. References

[1] Allwood, J., "Om det svenska systemet för språklig återkoppling" in P. Linell, V. Adelswärd, T. Nilsson, & P.A. Pettersson (Eds.) *Svenskans Beskrivning* 16, Vol.1. (SIC 21a), University of Linköping, Tema Kommunikation, 1987.

[2] Allwood, J., Nivre, J. and Ahlsén, E., "On the Semantics and Pragmatics of Linguistic Feedback" in *Journal of Semantics*, 1992, also in Gothenburg *Papers in Theoretical Linguistics*, 64, University of Göteborg, Dept of Linguistics, 1992.

[3] Ward, N., "Using Prosodic Clues to Decide When to Produce Back-channel Utterances" *Proceedings of the 4th ICSLP, Vol.3*: 1728-1731, 1996.

[4] Lindahl, I. "Språklig återkoppling i dialoger", Lund University, unpublished; 2001.

[5] Allwood, J, Grönqvist, L., Ahlsén, E., and Gunnarsson, M., "Annotations and Tools for an Activity Based Spoken Language Corpus". In J. van Kuppevelt & R. W. Smith (eds.) *Current and New Directions in Discourse and Dialogue*. Dordrecht: Kluwer, 2003.