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High-pitched prominences in the speeches of the male Polish members of parliament

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Abstract

The tendency to use a lower voice in public speeches may be well justified by evolutionary and social factors. Low, stable voice is often associated with authority and persuasive power while high-pitched voices are linked to intensive active emotions. In this light, the occurrence of extremely high intonation peaks or falsetto voice in public speeches by male speakers is puzzling and requires explanation.

In this study we analyse the usage of high-pitched intonation peaks in ten male members of the Polish parliament based on recordings selected from the *MuMo Stance* Corpus of German and Polish Parliamentary Speeches. The speeches are scrutinized for high pitched prominences using the criteria of (a) relative pitch range and (b) top pitch value relative to the mean pitch of each speaker. The material includes also prominence areas annotations for: hand gestures, head, body movements, and the discourse functions realized by the respective utterances. We qualitatively explore on the distribution, form, and function of high-pitched prominences, and their co-occurrence with gestures and body movements.

We find the usage of high-pitched prominences to significantly differ among and within speeches. While they tend to co-occur with gestures, the connection of their characteristics with gestural features is not straightforward.

Index Terms: high-pitched prominence, hand gesture, public speeches

1. Introduction

Public speeches in politics are intended to impress and influence both the direct addressee, e.g., political opponents in a discussion, and the witnessing audience. A wide spectrum of rhetorical means of persuasion is used for this purpose. Illocutionary force relies not only on the choice of words and their particular sequencing. Prosody and gesticulation play important roles in the dynamics of persuasive utterances and in the process of persuasion. They contribute to the linguistic and paralinguistic meaning. Therefore, the ultimate analysis of public speeches in terms of persuasive features and illocutionary force should be multimodal and cover the acoustic details of utterance's realization as well as accompanying body movements.

Public political speeches were readily explored for their prosodic characteristics, e.g., [1,2,3] because of their social importance and impact but also because of the charismatic speakers themselves: their strong, highly emotional personalities, using rich repertoires of prosodic means, e.g., [4]. The same applies to the gestural behaviour of politicians, e.g., [5-9]. Much research on political speeches refers to the aspects of authority and power, e.g., [10-13], but linguistically they also obviously relate to persuasion and illocution. Even though the significance of the gestural component is evident [14], still only a limited number of studies are fully multimodal, e.g., [15,16].

Pitch is a strong factor in shaping both the linguistic and paralinguistic meaning of spoken utterances. Pitch changes are related to the syntax [17,18,19] and information structure of utterances [20], and to their discourse functions [21]. But the same dimension of pitch change is employed to express emotions, feelings and attitudes [22,23,24]. It can be applied strictly locally, e.g., to lend prominence to a syllable, or to a wider stretch of speech, by changing "pitch register". In the latter case, it may indicate prolonged emotional arousal, but it can also mark, for example, the parenthetical status of a portion of an utterance [25]. When combined with age, gender, body size, or individual speaking style, it generates a huge palette of potential interpretation issues which are faced by both regular language users and linguists. Studies on high pitch usage and functions help to understand various social phenomena and emotional dynamics in the process of communication. High pitch is one of the features attributed to infant-directed speech [26]. A wider pitch range may increase persuasive force of an utterance but excessive *f0* peaks may have an opposite result [27,4]. Many studies relate also to social roles, gender, or politeness, e.g., [28,29,30]. Mayew et al. [31] directly point to advantages of a lower voice in their study of business leaders with major companies and conclude that a lower voice means a better leader.

The extra- and paralinguistic usage of pitch is mostly explained from two major perspectives. The theory of biological codes [32,33] and, specifically the idea of frequency code [34,35], explains why low pitch is associated with strength and power of the speaker: Lower voices normally belong to bigger creatures who tend to have bigger larynxes (or their equivalents), capable of producing lower sounds because of the extended length of the vocal cords. Ethnographically oriented perspectives provide a more nuanced, multifaceted, context-conscious view that involves social, mental, and cultural factors, resulting in relatively complex models [36-39]. For example, Stross [39] suggests that meanings associated with falsetto voice are largely arbitrary and explainable based on “observational logic”. Nevertheless, these two perspectives on the paralinguistic pitch usage are rather complementary than mutually exclusive, and both should be taken into account in explaining the paralinguistic usage of pitch.

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In the present paper, we report on a preliminary exploration of the usage, form and functions of high pitch peaks in phrase accents and co-occurring hand, torso and head movements in the speeches delivered by male members of the Polish parliament. The aim is to capture basic characteristics of these phenomena and prepare grounds for formulation of hypotheses for further quantitative research.

2. Pitch trace and body movement analysis

2.1. Study material

A subset of the *MumoStance* corpus of German and Polish Parliamentary Speeches (developed within an on-going project, see: Acknowledgements and https://mmstance.home.amu.edu.pl/) was used as the study material. The corpus consists of audio and video recordings of parliamentary speeches delivered by the parliament members during 2020 budgetary debates, as well as multilayer time-aligned annotation of speech (the level of phrase, word, syllable and phone) and visual components emphasizing expressive function of gestures, i.e., expressive movements, foregrounding clusters [40,41]. The Polish section of the corpus includes 69 speeches. Individual speech durations range from 00:51 to 26:07; most of the sessions are shorter than 2 minutes (average speech duration: 4:45, the median: 01:39). All the recorded speakers were standing while speaking. With body movements, their distance from microphones was changing, which may influence some acoustic-phonetic measurements.

For the purpose of the present work, a randomly selected sample of ten Polish parliamentary speeches delivered by male Members of Parliament was explored for extreme *fo* levels and level changes in the phrase accent. For all of the selected speeches, the prosodic prominences were annotated for accompanying hand, head, and torso movements, as well as rhetorical functions of the respective utterances. The speeches under investigation differ in terms of duration (from 62 to 729 seconds), include speakers of different age and of various political views.

2.2. Selection of the prosodic prominences

Two criteria were applied to the prosodic prominences functioning as phrase accents in order to select material for further analysis as they both may lean prominence based on the dimension of pitch:

(a) Relative pitch frequency level: Prominences involving pitch frequencies higher than the mean pitch value of the given speaker plus the value of standard deviation calculated from entire speech on the basis of pitch listing obtained from Praat [42] (standard parameters, autocorrelation method).

(b) Relative pitch frequency change: Peaks which were involved in the phrase accent with the relative frequency change by more than 50% from the preceding pitch valley. While this criterion does not refer directly to high pitch, in practice most of the pitch frequency changes of that size start or stop at a relatively high frequency.

Due to a high number of *fo* extraction errors caused by both voice and recording quality, as well as problems with automatic detection of relevant *fo* maxima and minima, measurements were taken manually and individually controlled using Praat pitch extraction with standard parameters and range adjusted to each voice separately. In order to obtain global pitch parameters required for the criterion (a), pitch listings obtained from Praat editor window were used. They were manually checked for major errors resulting from pitch frequency extraction problems. To obtain a smoother and more balanced picture of pitch changes, moving window average *fo* values were also calculated using a customised Annotation Pro plug-in [43, 44].

2.3. Hand, head and torso movement annotation

For the prosodic, pitch-based prominences, co-occurring hand, head and torso movements were annotated. The analysis was focused on the stretches of major pitch change, between the minimum and maximum values. As a result, it mostly applied to very short portions of movement (gesture phase or even part of it) and a limited number of their parameters. Therefore, we avoid referring to them as gestures as some of them might not fall in this category [45,46]. Hand movements were annotated in terms of their direction and relative size (gesture space usage). Head and torso movements were described only in terms of direction. To describe the direction of hand, head and torso movements, the following labels were applied:

1. Hand movement direction: up, down, side, static (no movement)
2. Head and torso movement: toward, back and side (movement direction described relative to the audience)

In order to annotate the size of hand movements, speaker's gesture space [45,47] was divided into the following sections: table (movements produced just over the rostrum), belly, lower chest, upper chest, arms. The relative size of hand movement was defined using numbers from 1 to 5, depending on how many sectors of the gesture space were involved.

2.4. Rhetorical acts

Phrases featuring selected prominences were annotated for rhetorical function category according to the system proposed by [48] with small adjustments to fit the profile of the current corpus. Rhetorical functions were annotated by two experts who negotiated tags and labelled 234 out of the total of 249 utterances. The remaining ones were incomplete or impossible to interpret because of some other reasons. Due to the profile of the speeches, the inventory of rhetorical functions was limited, some of them represented by just few occurrences (e.g., performative, question).

2.5. Collected data overview

In total, 249 cases of prominences meeting the criteria (a) and (b) above were selected for further analyses and supplemented with hand, head and torso movement annotation. For 227 cases, the condition of pitch height (a) was met, while 100 cases matched the condition of relative pitch change (more than 50%), which means that a significant proportion of the selected prominences met both the conditions. Additionally, global pitch parameters were extracted for all the speakers using Praat. Mean pitch value ranged from 130 Hz to 208 Hz. For 179 out of the total of 249 prominences (69.48%) any kind

of annotated movement occurred (hands, torso or head). Hand movements were noticed in 125 cases while torso or head movements in 78 cases.

Pitch extraction issues led to a serious reduction of the number of analysed cases. Voice quality often significantly changed when reaching top frequencies from speaker's physiological range, resulting in problematic or less reliable measurements. When the cases of a wide pitch range are considered, the low end of the spectrum measurements were also relevant, and here, as it might be expected, creaky voice as well as devoicing often occurred. Given these and other limitations, we restrict this study mostly to qualitative observation and hypothesizing on some tendencies that may become visible when more material is available and more robust methods of analysis are applied.

2.6. Pitch frequency and movement analysis

Pitch movement around the phrase accent syllable was, in most cases, typical of the Polish language, and followed a rising or a falling pattern, with a limited number of falling-rising and rising-falling melodies as shown in Fig.1. In order to match the physical level of gesture analysis and avoid phonological interpretation, pitch analysis was carried out on the acoustic-phonetic level, with no direct references to phonological categories. The inventory was dominated by the falling (61%) and rising (32%) patterns. While traditionally, rising nuclear melody (around the phrase prominence) is associated with questions in Polish, many resources show that it may occur in other functions and contexts. This is confirmed by our data where, for example, many varieties of statements were also produced with a rising nuclear tone. Given this unclear function-form relation, we abstracted from sentence categories as potential justifications for using high-pitched prominences, although they cannot be rejected as a potential factor.

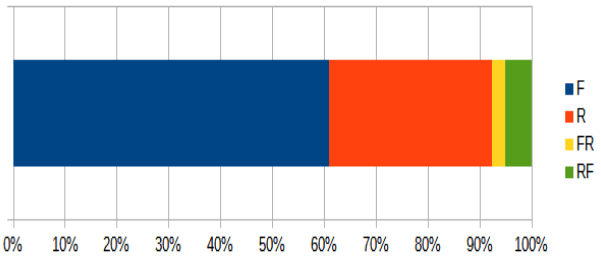

Figure 1: *Pitch change direction on the phrase-accentual syllable (F - falling, R - rising, FR - falling-rising, RF - rising-falling; numbers of occurrences are shown in the chart)*

Mean pitch frequency of the speakers in the selected sample was unexpectedly high, reaching even above 200Hz, atypically of male voices. It was noted however that high-pitched speakers tended to start with a lower voice (e.g., when greeting the chairperson of the sitting and the audience) and switched to a higher pitch register shortly afterwards as shown in Fig 2. Some of them were returning to the lower pitch register and back to the higher register a few times. This, in turn, may be an obstacle in the interpretation of the mean as a reference pitch level. While local pitch frequency taken as a reference level would be a solution, it would raise a number of other issues. For example, the *fo* value ceiling and floor for a speaker remains, in principle, the same throughout the speech, independently of the local mean value; therefore, high peaks rising from a stretch of high-pitched speech would be compressed, while a high peak under analysis may happen to rise from a narrower valley. Measurements at the boundaries of high-pitched areas may be problematic as the mean pitch frequency value would be lowered for windows encompassing some portions of the regular or low pitch area.

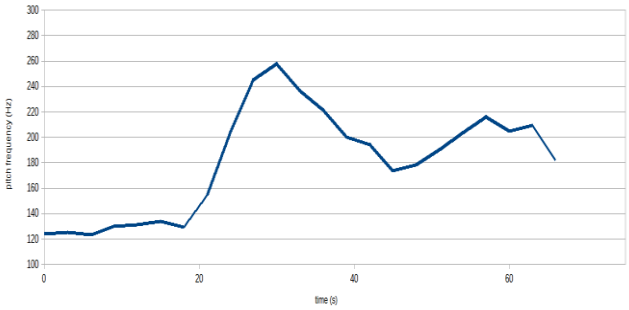

Figure 2: *Pitch frequency change in a short speech (based on a moving 9-second window with a 3-second shift overlap)*

To get a preliminary picture whether the proportion of movement-accompanied prominences may increase during the speech, the number of movement-accompanied cases was calculated for the first and last third part of annotated peaks for each speaker (abstracting from their times of occurrence in the speech). The result does not suggest any significant difference (58 vs. 61 cases, respectively). However, when the first and last thirds of annotated prominences were compared in terms of the accompanying movements' size (defined by the usage of gesture space), a difference was noticed. As shown in Table 1, in the later stage of the speech, movements tend to be larger. While, again, this analysis abstracts from the times of occurrence, it allows to formulate a hypothesis for further quantitative testing. We also were looking for a correlation between pitch change and movement size as well as between the maximum pitch in a given prominence and movement size, but results indicated no significant relationship in our sample (r=-0.04 and r=0.18, respectively).

Table 1: *Movement size of hand movements co-occurring with the analysed prominences earlier and later in the speech*

Movement size	Co-occurring with	
	earlier prominences	later prominences
0	47	38
1	25	11
2	14	18
3	2	12

As expected, most of the high-pitched phrase accents were accompanied by hand, torso or head movements. Nevertheless, tedious exploration of the entire material in hand will be required to address the question of the proportion of

high-pitched and other prominences accompanied by movement. The proportions of pitch rises and falls accompanied by hand movements and by any movements were almost equal (although the numbers or rises and falls in our inventory were significantly different; see earlier in this section). The proportion of prosodic prominences meeting the criterion of pitch range (pitch frequency change > 50%) and accompanied by any annotated movement was 70.64% while for the prominences not meeting this criterion, the proportion of movement-accompanied ones reached 75.00%. The data support the hypothesis that there are a number of potential configurations: the direction of hand movement is not simply related to the direction of pitch movement (there are numerous examples of both situations: same direction and opposite direction).

Table 2: *The proportion of rising and falling prominences accompanied by hand movements, torso or head movements, and by any of them (rising-falling and falling-rising cases are not shown)*

	Hand movement	**Torso or head movement**	**Any movement**
Rising pitch	49.37%	27.85%	67.09%
Falling pitch	49.01%	31.79%	69.54%

Finally, we reviewed the categories of rhetorical acts realised in the phrases featuring phrase accents meeting the criteria listed in 2.2. As shown in Table 3, two major categories dominated the sample: statement no-opinion and statement with-opinion. This is not surprising and we expect that their proportions may be similar in the entire corpus as statements seem to be basic building blocks of this type of monologues.

Table 3: *Rhetorical acts performed in utterances containing the selected prominences accompanied by hand movements, torso or head movements, and by any of them (rising-falling and falling-rising cases are not shown)*

Rhetorical function	**Total no. of occurrences**	**Involving**		
		hand movement	**torso / head movement**	**any movement**
Statement no-opinion	139	69	42	94
Statement with opinion	40	26	14	33
Apeal no opinion	16	5	8	11
Rhetorical question	13	8	0	8
Speech organization	10	3	2	5
Other categories	16	6	7	13

3. Discussion and conclusion

In the present study, ten speeches delivered by male members of the Polish parliament were explored for pitch-based prominences selected with two criteria: top pitch frequency value and pitch frequency range. The prominences were annotated for basic acoustic features (maximum and minimum pitch frequency values) as well as for co-occurring hand, head and torso movements. The study was focused on the form and function of prominences, including selected multimodal aspects, and intended as a preliminary qualitative exploration of the new multimodal *MuMo Stance* corpus in search of potentially important phenomena related to multimodal stance taking [49].

In our sample, we found 151 examples of falling, 79 cases of rising nuclear melody, and a few examples of more complex contours. The domination of falling contours is expected due to the profile of the speech, based mostly on statements (see the summary of rhetorical acts). Statements in Polish may be also realised with a rising melody, which explains a relatively high proportion of rises. A question arises if the proportion of nuclear melodies around the selected prominences is significantly different from what can be found in the remaining part of the corpus. In our sample, the proportion of selected movements types accompanied by rises and by falls was very similar, which also may be tested in the future for a larger part of the corpus. We found that while the number of movement-accompanied prominences may remain on a relative constant level during the speech, the size of movements may grow. According to our observations and findings, it may be hypothesized that the number of high-pitched prominences as well as the local average pitch value tend to grow throughout the speech. We have not found any simple and direct correlation between the direction and size of the pitch change and the direction and size of the movement, cf. [50]. However, more complex relations, involving more variables and, for example, of compensatory nature, are not excluded. It is also obvious at this point that, as Sicoli [51] points out, high pitch has an extremely wide range of functions.

With further development of the *MuMo Stance* corpus, more prosodic and gestural data will be available, and the size of the usable material will increase. This should allow to test at least some of the abovementioned hypotheses. Addressing the question of how the use of high pitch and specific body movements influence the persuasive aspects of speech would require perception studies. On the other hand, we touch very individual features of communicative behaviour, and relying on shallow quantitative comparisons may not provide a reliable picture of the phenomena under study. Therefore, we intend to pay more attention to intra-speaker variability, as suggested e.g., by Podesva [38], focus on specific categories of communicative behaviour, guided by the framework of affective movement analysis.

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