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ОСОБЛИВОСТІ ВИСОТИ ГОЛОСУ В ІНТЕРВ'Ю ЕЛІЗАБЕТ ХОЛМС

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VOICE PITCH PECULIARITIES IN ELIZABETH HOLMES' INTERVIEWS

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Статтю зосереджено на дослідженні висоти голосу як одного з ідентифікаторів обману та висвітленні особливостей використання заниженого тону на прикладі інтерв'ю Елізабет Холмс. Аналіз здійснено за допомогою програми PRAAT, а точніше скриптової мови, відомої як Prosogram. Даний скрипт уможливлює аналіз голосових файлів wav. та презентує отримані дані у візуальній формі профілю мовця. В результаті проведеного аналізу з'ясовано, що низка профілів демонструє тенденцію непослідовності у використанні тону між різними інтерв'ю та промовами. Водночас отримані дані також вказують на протилежний результат в межах одного інтерв'ю. В даному випадку мовець підтримує висоту свого голосу на відповідному рівні протягом всієї розмови з мінімальними коливаннями. Окрім того проведений аналіз також надає підстави стверджувати, що поведінка мовця не зумовлена статтю співрозмовника/-ці і спричинена іншими соціальними чинниками. Для подальшого дослідження запропоновано аналіз мовленнєвої поведінки та порівняння об'єкта дослідження (в нашому випадку висловлення Елізабет Холмс)з виступами інших відомих головних виконавчих директорів.

***Ключові слова**: висота голосу, мовленнєва поведінка, Елізабет Холмс, Prosogram, профіль мовця*

This article focuses on the study of voice pitch as one of the identifiers of deception and highlights the peculiarities of using a lowered tone on the example of an interview with Elizabeth Holmes. The analysis was carried out using the PRAAT program, or rather a scripting language known as Prosogram based on it. This script enables the analysis of voice wav files and presents the data in the visual form of a speaker profile. As a result of the analysis, a number of profiles demonstrate a tendency of inconsistency in the use of tone between different interviews and speeches. At the same time, the data also shows the opposite result within the same interview. In this case, the speaker maintains the pitch of his voice at the same

level throughout the conversation with minimal fluctuations. In addition, the analysis also suggests that the speaker's behavior is not conditioned by the gender of the interlocutor and is caused by other social factors. For further research, we propose analysis of speech behavior and comparison of the subject of study (in our case Elizabeth Holmes' talks) with contemporary CEOs.

***Key words**: voice pitch, speaking patterns, Elizabeth Holmes, Prosogram, speaker's profile*

Introduction. Thus far the technology that we have now can predict the abnormal speaking patterns with the accuracy ranging from 80 to 90 % (Evans, 2018). However polygraph results could be manipulated, and therefore, are not admissible in court for this reason. Still people have this fascination regarding deception and its manifestations. They developed a number of methods that may increase the lie detection ratio by other means, including an analysis of subjects' behavior. That usually entails observing body language, gestures, facial expressions, etc or conducting experiments in controlled situations.

Problem Statement. Since the potential liar could be aware of their behaviour, they are able to predict and manipulate certain aspects of one. Therefore it is important to cover the possible change in consistency of person's speaking habits and trace those to indicate the possible pattern. In this case we will review the pitch aspect of lying in the case of Elizabeth Holmes speeches in particular. We suspect to observe inconsistencies in usage of speaking patterns, which is a direct result of cognitive load.

Analysis of the latest research and publications. High pitch, one of the vocal cues, is commonly an indicative of deceitful speech. The issue, however, is that in the case of Elizabeth Holmes, what we could actually hear is the opposite.

In the American Scientist article Casey A. et al. (2017) note that voice pitch is "an expression of physiology, not psychology". That being said any purposeful change of pitch might seem unnatural to the listener and therefore should be addressed by the speaker, if one intends to influence their core audience. This makes the case of Holmes particularly noteworthy, since she purposefully lowered her tone and pitch in order to sound more masculine. In the New York Times interview (2023), it is stated directly:

"In case you're wondering, Ms. Holmes speaks in a soft, slightly low, but totally unremarkable voice, no hint of the throaty contralto she used while running her defunct blood-testing start-up, Theranos."

Moreover, her family seems to acknowledge that fact as well (The NYT, 2023), as it is also reflected in the article with the following comments:

– "…even Mr. Evans agrees, the voice was real weird."

– "That would be crazy, if she answered the door and said, 'Hi. I'm Elizabeth Holmes," Mr. Evans said, imitating the voice. Ms. Holmes let out the slightest of giggles from the back seat."

The possible rationale for using a deeper pitch could be creating an image of a person in power. For example, Mayew et al. (2013) present the correlation between a lower pitch and success on the labour market. They state that males with a deeper voice are more likely to get and retain a job in larger firms.

According to Klofstad (2012), people tend to opt for a person with a lower voice when it comes to someone in charge; that goes for officials or other leadership positions. It is not limited to gender specifically, since participants preferred someone with a lower pitch, whether that was male or female.

Quite the opposite idea was presented in Midam Kim's paper (2022). She claims that the lower pitch did not produce a desirable outcome in the audience perception, because of the different expectations people hold for women.

"Low pitch is an auditory cue that has been expected of men leaders. So, first of all, people have not had many experiences with women leadership – so it's hard to apply the same auditory expectation for women leaders" (Kim, 2022).

From this we can assume that both listeners and speakers have the preconceived idea of the way lie may look or sound like. This leads us to the fact that some people might exploit this belief. According to Loy et al. (2018) liars have an understanding of the works of deception and are thereby able to manipulate those to an extent. Still, in their findings, they present the following: "Guessers' impressions about lying reflect the cognitive hypothesis, where producing untrue utterances requires additional mental effort, resulting in cue behaviours indicative of this load (Sporer & Schwandt, 2006; Vrij, 2000)."

Purpose. The article aims to trace the changes in pitch and define possible factors that may or may not affect the pitch of the speaker.

Results. In this study we rely on perceivable fluctuations and changes in pitch and a Prosogram script to showcase prosody. The latter is a script of PRAAT, a model designed to capture and visualize the pitch variations. It presents a visual profile of a speaker to which we will refer further (Prosogram, n.d.).

In order to cover the apparent differences in pitch, we used a generated speaker profile with the help of a Prosogram script. For this analysis we used different interviews and promo videos that featured Elizabeth Holmes. The video samples were segmented and converted into wav. files for further analysis. Some of the parts were abridged to separate the speaker from the other noise (e.g., the interviewer talking and interrupting). Prosogram provides two values which are used to measure

the range of pitch: semitones (ST) and Hertz (Hz). However, we will refer to Hz for convenience and to avoid further confusion.

The profiles below are based on videos claiming to capture Elizabeth's real voice. Those are from her earlier speeches (posted in 2013) and one of the last public appearances before the WSJ exposé publication (posted in 2015) (Figure 1).

Pitch Range (after stylization)

	ST	Hz
range (span)	11.1	
top	97.2	275
mean	89.7	180
median	89.1	172
bottom	86.2	145
stddev	2.76	38.43

Pitch Range (after stylization)

	ST	Hz
range (span)	13.6	
top	98.3	293
mean	90.5	188
median	90.0	181
bottom	84.7	133
stddev	3.01	38.08

Figure 1 speaking profiles based on Elizabeth Holmes' speeches (with perceivable higher pitch 2013, 2015)

In Figure 1, the mean for the pitch ranges from 180 to 188 Hz. It correlates with the average mean for a female speaking voice, which is around 200-220 Hz (Berg et al., 2016), albeit still being on the lower end. In addition to this, the similarity of this data may suggest that the voice remains consistent. The consistency, in turn, leads us to believe that the pitch produced might be real or close to the real range of Holmes, especially taking into account the difference in time of recording. However, it highly contrasts with Figure 2 presented below. In this instance, the profile was created from the promotional video for the Theranos company (2014). Here, the mean is around 150, and although it does not seem significant, perceptibly, the contrast is apparent, especially taking into account the lowest value of 96 Hz.

Pitch Range (after stylization)

	ST	Hz
range (span)	12.7	
top	91.7	200
mean	86.5	150
median	86.9	151
bottom	79.0	96
stddev	2.81	26.89

Figure 2 Better Blood Test Experience - Theranos 2014 (speaking profile)

To compare, the mean for the average male speaking voice is at 100-120 Hz. Although the speaker does not reach that low pitch-wise, we can observe a proclivity that is manifested in the recordings. The mean however might fluctuate depending on a number of factors such as age, lifestyle, voice

intensity (whether a speaker is using a shouting or conversational voice), smoking status, etc. (Berg et al., 2016).

Therefore, to assess the general picture further, other interviews were analyzed. It seemed reasonable to juxtapose Elizabeth Holmes with her interlocutors. It was done with intention to check whether gender of interviewer had any effect on her speaking patterns. In the following examples, samples were compared to male (WSJ, 2015) and female (Fortune Magazine 2014, 2015) interviewers. Those samples were cut to match the speaking time for each subject.

Pitch Range (after stylization)

	ST	Hz
range (span)	16.6	
top	97.7	282
mean	88.0	165
median	87.6	158
bottom	81.1	108
stddev	3.54	37.94

Pitch Range (after stylization)

	ST	Hz
range (span)	10.8	
top	84.1	129
mean	77.8	90
median	77.3	87
bottom	73.3	69
stddev	2.50	14.45

Figure 3 WSJ, 2015 on the left Elizabeth Holmes, on the right male interviewer (speaker profiles)

The figures above are from the Wall Street Journal interview and show the difference in pitch range between the two interlocutors. The male interviewer has the lowest register of all presented samples in this section, with a mean of 90 Hz. Elizabeth Holmes, on the other hand, has a mean of 165 Hz. The point of interest here, however, is the highest point of 282 Hz. This point indicates an emphatic stress, which is a typical pattern for Elizabeth Holmes' interviews.

Pitch Range (after stylization)

	ST	Hz
range (span)	13.7	
top	94.1	229
mean	85.8	143
median	85.2	137
bottom	80.3	104
stddev	3.09	30.70

Pitch Range (after stylization)

	ST	Hz
range (span)	22.4	
top	98.9	303
mean	88.6	171
median	87.9	160
bottom	76.5	83
stddev	4.09	44.49

Figure 4 Fortune Magazine 2014 Elizabeth Holmes on the left, female interviewer on the right

The samples presented above are from Fortune Magazine (2014) with a female interviewer. The other speaker has a relatively lower voice, yet the contrast between the interviewer and Elizabeth Holmes' pitch is perceivable and is reflected in the figures above. In addition to this we can trace the fluctuation of voice. Those were less distinct in comparison to the data provided previously. During the interview the voice of the subject (Elizabeth Holmes) was relatively monotonous, and it did not reach the highest points as she used to.

Everything mentioned above thus far deals with the patterns throughout her active career as entrepreneur. So, to further the idea, we decided to take several segments from the same interviews to trace the consistency in pitch within one recording as well. The figure below presents three separate samples of Elizabeth Holmes from the beginning, middle, and end of the CHM Revolutionaries conversation. The data is presented in order.

Pitch Range (after stylization)

	ST	Hz
range (span)	15.0	
top	94.2	230
mean	83.6	126
median	83.2	122
bottom	79.1	97
stddev	2.78	24.77

Pitch Range (after stylization)

	ST	Hz
range (span)	13.6	
top	93.5	222
mean	84.3	132
median	83.9	127
bottom	79.9	101
stddev	2.95	29.59

Pitch Range (after stylization)

	ST	Hz
range (span)	13.4	
top	90.1	182
mean	84.1	129
median	83.9	127
bottom	76.7	84
stddev	2.44	18.57

Figure 5 CHM 2014 (Elizabeth Holmes' speaker profile)

The data from profiles above shows that the voice pitch remains overall consistent with a mean of 126 Hz (beginning), 132 Hz (middle) and 129 Hz (end) with the minor fluctuations for the top figures. It contrasts with the data from other interviews where Elizabeth Holmes' pitch may range drastically.

Conclusions and further research prospects.

From the obtained results we may conclude that our initial expectation of spotting inconsistencies in pitch change are partially confirmed. The changes are significant when comparing the data from different sources (interviews). The change of voice is not attributed to aging since the observed fluctuations appear on different occasions from multiple time-frames. Nonetheless the data from Figure 5 also presents an opposite result. The subject is able to maintain the consistent pitch that may suggest a little effect of cognitive load in this aspect in particular. In addition to this we can state that gender of the interlocutor has no effect on the change of pitch. It is open to speculation whether Elizabeth Holmes was governed by any socioeconomic factors in that regard.

For further research we would like to expand to more comparative analysis, where as we did with interlocutors we juxtapose our subject to other figures of interest. In this case it would be an infamous ex-CEO of FTX Sam Bankman-Fried, that will or will not show a distinction in speaking patterns. It is also our intention to continue the work on other prosodic features with the help of Prosogram script providing more detail on other slight changes in stress, rhythm, intonation, etc.

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