Trajectory of aloud voice in the Voice range profile, differences between supported and habitual voice in shouting.

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Abstract

To describe differences between habitual and supported voice usage in voice professionals (N=20) and non professionals (N=20) we compared following acoustical parameters of voice range profiles (VRP, phonetograms): Pitch position [midi] and RMS [dB] were measured for both conditions in following tasks: reading of standard text in normal loudness level and aloud, and shouting [ma:ma] with increasing intensity. Our results showed that voice professionals use the voice in a similar way for both conditions. Maximal loudness positions move in the specific trajectories in the whole VRP – in so called "loudness axis", both in habitual and grounded voice. The only differences we observed were in the beginning point of VRP, which is higher and louder in grounded than in habitual voice.

Introduction

Voice range profile (VRP) is a useful tool for diagnostic and didactic purposes. It can be used for the simply visual presentation of voice properties as a graph of loudness versus pitch, and provides information about tonal and dynamical ranges of the voice, which is necessary in clinical evaluation of voice quality [1].

The goal of VRP examination is to measure minimal and maximal loudness for each given tone, i.e. the maximal dynamical range for one tone in the whole tonal range. In addition, graphical visualization provides usable tool for identification of voice registers [2] or regions of specific voice problems [1].

In our study we aimed to characterize the maximal loudness trajectory of the voice. Since there are already studies describing the relation between the voice loudness and the pitch in voice effort [3][4], we focused on characterization of differences between habitual and supported voice usage.

Material and methods

We recorded two modes of the voice usage: habitual - normal voice, and supported voice in a group of twenty voice professionals (singers and actors, 10 males, 10 females) and twenty non-professionals (beginning students of acting, 11 males and 9 females). Following tasks were recorded for both conditions: reading of standard text in the normal loudness level and aloud, shouting [ma:ma] with successively increasing intensity. Recordings were made in the non echoic room. Distance between respondent's mouth and a microphone was 30 cm.

In order to determine trajectories of maximal voice loudness we calculated the signals the energy tracks and fundamental frequency tracks of the signals; by means of root mean square (RMS in dB) and by mean of autocorrelation in Hz, (then transformed to midi semitones), respectively. To determine the tracks we used a window of 30ms with step of 10ms. The tracks were visualized in VRP graphs, where the pitch [midi] was placed on the x-axis and RMS [dB], which corresponded to energy or loudness of the signal, was placed on y-axis. Next, we identified points of the maximal loudness of VRP for each given tone in pitch and its maximal energy was determined. From these points a trajectory was modeled by means of polynomial function of the second order (quadratic function). The trajectories of habitual and supported voice usage were compared.

For the next analysis were chosen trajectories from maxima of both conditions. These trajectories were organized in 3D plot where mean of the habitual pitch was placed on the z-axis. This coordination seems to be useful for the aim of trajectory trends between respondents.

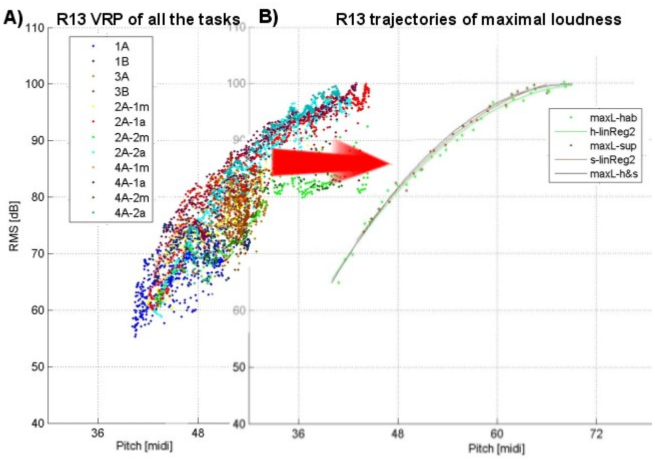

Fig. 1: A) Voice range profile of all the tasks and conditions for one respondent (reading of standard text in normal loudness level and aloud; shouting of the word [ma:ma] with successively increasing intensity). B) Points and modeled trajectories of maximal loudness from the VRP. (Green points and lines for habitual voice usage, brown for supported, black for the mix of habitual and supported VRPs.) In this case all trajectories are very similar.

Results

When the maximal loudness trajectories of habitual and supported voice were compared, three different scenarios were observed:

1. both of trajectories were equal;
2. trajectory of habitual voice laid under trajectory of supported voice in whole pitch range;
3. lower part of trajectory of habitual voice laid beneath the supported trajectory and high part of trajectory laid above that trajectory.

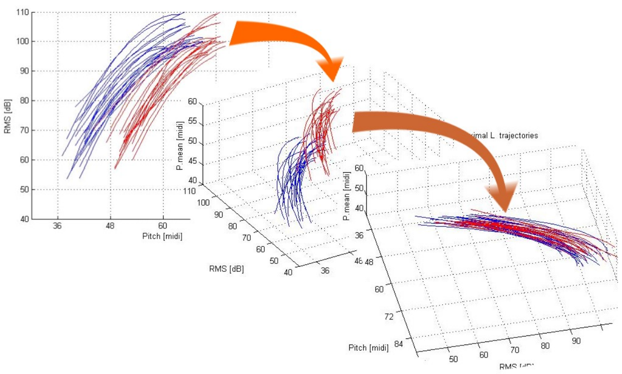

Fig. 2: Trajectories of maximal loudness for all 40 respondents (blue lines for males and red for females). Organization in 3D space (x- axis represents pitch, y- axis represents RMS and z- axis represents mean of the habitual pitch) shows possibly correlated system.

However, the above described assignment into groups demonstrated no correlation in the organized visualization in 3D plot, so that trajectories of maximal loudness from both habitual and supported usage were used for the next analysis. By doing so, several correlated systems corresponding to groups with different voice pathologies were observed in 3D diagram (pitch x loudness x mean of pitch in normal voice). Accordingly, we could differentiate between a group of six respondents with normal voices (without pathology, depicted in the Fig. 3), a group of ten respondents with soft breathiness and a group of six respondents with intermediate breathiness particularly in the higher parts of VRP. The comparison of group of normal voices (green) and intermediate breath voices (red) is highlighted in figure 4.

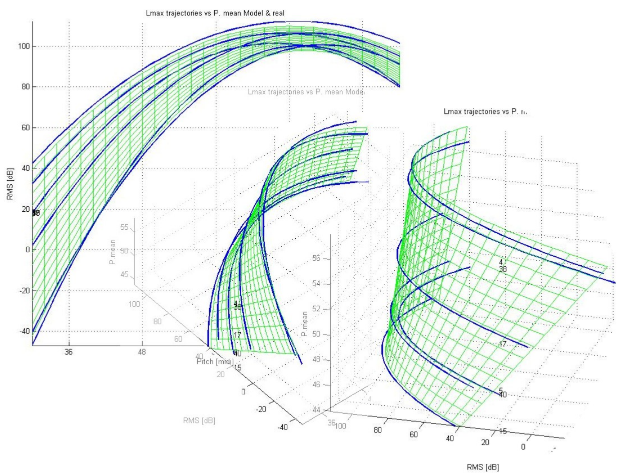

Fig. 3: Trajectories of maximal loudness for both habitual and supported voice usage for the group of respondents with normal voice (without pathology), organized in 3D diagram by mean of habitual pitch. This group shows very clear correlated system for both males and females (N=6).

Comparison of normal and breathy voices shows that normal voices had generally higher values of loudness and steeper rise in loudness in relation to pitch than breathy voices. However, in both systems, individuals with higher average habitual pitch (i.e. mainly women) have a steeper rise in loudness in dependence on pitch.

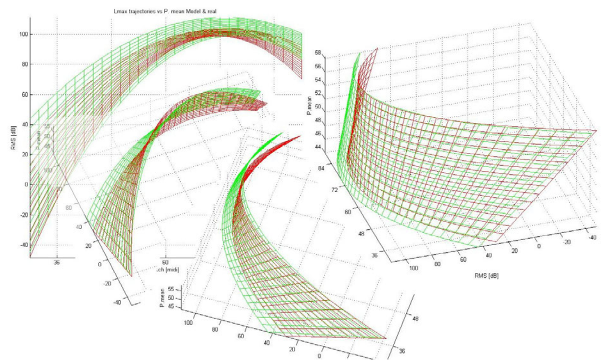

Fig. 4: Comparison of two groups of correlated systems, green for normal voice and red for voices with breathiness. Breathy voice typically has lower energy in trajectories of maximal loudness and slower rise in loudness in dependence on the pitch for both males and females.

Conclusion

Trajectory of maximal loudness in relation to pitch in shouting with progressively increasing intensity seems to be a useful tool for characterizing voice pathology. We found that systematic models of maximal loudness trajectories of normal voices were unique in males and females.

Acknowledgement

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References

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