VOICE PARAMETER CHANGES IN SMOKERS DURING ABSTINENCE FROM CIGARETTE SMOKING

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ABSTRACT

This study aimed at establishing how vocal parameters change following a period of abstinence from cigarette smoking. The voices of 18 smokers were examined after one week and then one month of cigarette abstinence. Changes in several acoustic parameters (jitter, shimmer, harmonics-to-noise ratio (HNR)) were analysed. During abstinence, jitter and shimmer decreased significantly, whereas HNR increased significantly.

Keywords: smoking, abstinence, jitter, shimmer, HNR

1. INTRODUCTION

The fact that cigarette smoking affects the larynx and leads to chronic diseases of the entire respiratory tract is widely known. [1, 8, 9] The histological changes in the larynx also lead to audible changes in smokers' voices. These changes and the differences between smokers' and non-smokers' voices are well-documented, cf. [2, 5, 7], whereas little research has been devoted to intraspeaker changes and the reversibility of these effects. In an early study, Wallner [9] confirms this reversibility based on histological analyses: "The best evidence we have at present is clinical, the fact that we can often reverse the disease process when the irritant is withdrawn." (p. 268). Hence, acoustic characteristics of a smoker's voice should also "improve" upon withdrawal.

Murphy and Doyle [6] were the first to address the question of intraspeaker changes. They compared the fundamental frequency of two smokers during their normal smoking behaviour with fundamental frequency after a short period of cessation and after resuming smoking. They found differences after 48 hours of smoking abstinence, i.e. a 6 Hz rise of fundamental frequency, and a decrease again after ending the abstinence.

Braun [4] broadens the perspective on smokers' voices by measuring various acoustic manifestations of hoarseness (jitter, shimmer, and HNR) in addition to fundamental frequency. She compared the voices of 20 smokers and 20 non-smokers.

So far, no further study has looked at voice parameter changes when a subject ceases smoking. Based on the findings of Murphy and Doyle [6], a rise in fundamental frequency is to be expected after stopping smoking, the findings of Braun [4] suggest a decrease in the values of jitter and shimmer and an increase in HNR. Furthermore, the lung volume/vital capacity and the airflow control can be expected to improve due to the "smoking stop", and as a consequence, the maximum phonation time should increase, cf. [2].

2. METHOD

2.1. Subjects, speech material and recordings

18 (5 female, 13 male) smokers took part in the experiment. They were recruited from several smoking cessation classes in Hesse, Germany. They were 26-64 years old (mean female 53.6 years, mean male 44.5 years). In order to be included in the study, subjects had to have smoked at least 10 cigarettes a day for at least 7 consecutive years. The subjects had smoked for 7-46 years (mean 27 years), consuming 15-20 cigarettes daily. None of them consumed any other tobacco products.

After filling out a questionnaire concerning their consumption of cigarettes, the subjects were asked to read the standardized text "Nordwind und Sonne" (The northwind and the sun), to describe a picture in a few sentences and to sustain the vowel /a:/ for as long as they could at a pitch of their choice. This last task was repeated three times in order to give the participants the possibility to get used to the task. If afterwards either the participant or the author felt that there could be a better version, more trials were recorded. For analysis, the auditorily best sustained vowel was used.

All subjects were recorded three times: once when still smoking (t0), then after a week (t1) and again after a month (t2) of abstinence. Recordings

were made in a silent room with a SONY Audio Hi-MD MZ-RH10 at 44.1 samples per second and 16bit amplitude resolution. At the time of the recordings, subjects reported no health problems or illnesses which might affect their vocal behavior.

2.2. Analysis

For the vowel the fundamental frequency, maximum phonation time, jitter, shimmer and harmonics-to-noise ratio were analysed. All parameters were extracted with PRAAT (vers. 5.1.16) [3]. Statistical analyses for the changes between measuring points t0 ("smoking") and t1 ("one week abstinence") and measuring points t0 and t2 ("one month abstinence") in each acoustic parameter were tested with a paired Student's t-test.

Analysis of the fundamental frequency for the reading and free speech showed no significant differences or tendencies to change above normal intrasubjective changes, therefore the results will not be reported here.

3. RESULTS

3.1. Fundamental frequency

After cigarette abstinence, most speakers chose a slightly higher level of pitch as "comfortable". Some subjects showed no change or even a small decrease in their fundamental frequency, but none of the decreases was greater than 10 Hz. Increases, on the other hand, went up to 30 Hz.

Table 1: Mean fundamental frequencies for the male and female subjects after abstinence.

	t0	t1	t2
Male (n=13)	103.27 Hz	107.08 Hz	109.71 Hz
Female (n=5)	187.37 Hz	192.91 Hz	207.19 Hz

3.2. Maximum phonation time

At measuring point t0, four smokers (two male, two female) were not able to sustain the vowel for more then 10 seconds [i]. During the period of abstinence, the maximum time subjects could phonate steadily increased, though differences between individuals were large. These changes are nonetheless very small and do not reach significance.

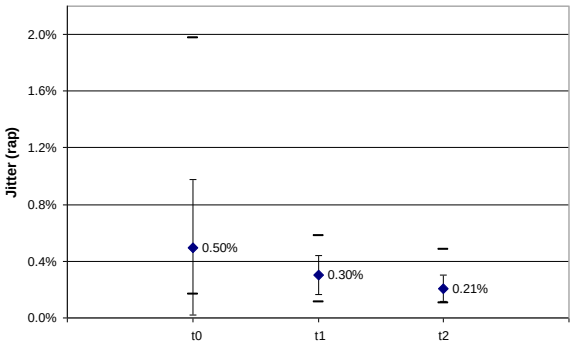
Table 2: Mean duration of /a:/, standard deviation (SD), minima and maxima of duration.

	t0	t1	t2
Mean duration [sec]	15.95	16.83	17.78
SD	7.20	7.14	6.81
Minimal duration [sec]	5.59	6.10	7.30
Maximal duration [sec]	36.59	31.06	37.11

3.3. Jitter

At t0, three subjects (all male) showed jitter values that could be clearly considered pathological according to MDVP[ii], none of them falls under that threshold at t1.

Figure 1: Mean jitter (rap), standard deviation, minima and maxima for the three measuring points.



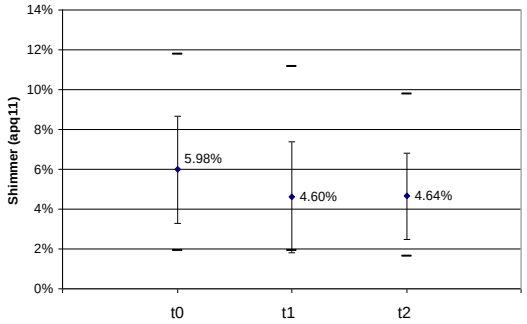
For 14 subjects, jitter values decreased noticeably after stopping smoking and even further over a longer time of abstinence. The changes in jitter between t0 and t1 were not significant, whereas the changes between t0 and t2 were highly significant (p=0.00954).

3.4. Shimmer

With respect to shimmer at t0, the voices of 15 subjects could be considered pathological according to MDVP[iii].

After one week of cigarette abstinence, the mean values for shimmer were considerably lower than when subjects were still smoking. Interestingly, no further decrease of shimmer occurred after one month of abstinence. For 13 subjects, shimmer decreased from "smoking" to "one week abstinence", but this trend is continued further to "one month of abstinence" for only 6 of them. The changes from t0 to t1 (p=0.03189) as well as t0 to t2 were significant (p=0.00988).

Figure 2: Mean shimmer (apq11), standard deviation, minima and maxima for the three measuring points.

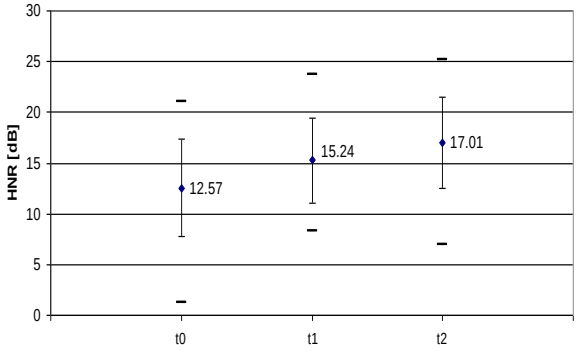


3.5. Harmonics-to-noise ratio

Mean harmonics-to-noise ratio rose significantly (p=0.01684) over a short abstinence (t0 to t1) and highly significantly (p=0.00006) over a longer abstinence of one month (t0 to t2). Means for the measuring points were: t0 12.57 dB, t1 15.24 dB, t2 17.01 dB.

At t0, two subjects (both male) showed a HNR of less than 7.4 dB, which can be considered pathological according to Youmoto and Gould [11].

Figure 3: Mean, standard deviation, minima and maxima of HNR for the three measuring points.



4. DISCUSSION

As was to be expected, the mean values of jitter, shimmer and HNR improved during the time of abstinence. These data confirm the findings of Braun [1]. Fundamental frequency changes similar to the earlier findings of Murphy and Doyle [8], who also found a rising tendency after smoking was stopped, and a falling when subjects resumed smoking. Nonetheless, the values for fundamental frequency have to be interpreted with caution due to the small sample. They ought to be regarded as tendencies.

Based on this small number of data for the acoustic parameters, shimmer seems to be a parameter which responds quickly and substantially to the absence of cigarette smoke, whereas jitter and harmonics-to-noise ratio show relatively slower changes over a longer period.

It would be interesting to have more measuring points over the time, and even over a longer time of abstinence, to see if these acoustic parameters approach the values of non-smokers.

5. REFERENCES

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[i] Wendler, et al. [10] consider maximum phonation duration below 10 sec. as certain pathological.

[ii] MDVP (Multi-Dimensional Voice Program, see PRAAT) considers 0.68% jitter as pathological threshold.

[iii] MDVP sees 3.07% shimmer as pathological threshold.