THE INFLUENCE OF SMOKING HABITS ON PERCEIVED AGE

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ABSTRACT

Direct age estimates of 40 adult male speakers, 20 of them smokers and 20 non-smokers, were made by a group of 12 trained phoneticians and a group of 19 phonetically naive listeners from recorded speech samples. The results indicate that the expert listeners did not do significantly better than the untrained listeners. Smokers were assessed to be older than non-smokers of the same calendar age. The interaction of several phonetic variables with listener judgement was investigated. Syllable rate and HNR turned out to be the only significant predictors of perceived age.

INTRODUCTION

It emerges from previous research that listeners are able to make fairly accurate judgements about a male speaker's age from voice cues. Shipp/Hollien [1] found a correlation of r = 0.88 between calendar age and perceived age; Neiman/Applegate [2] calculated a correlation of r = 0.77 based on the data published in Ryan/Burk [3]; Horii/Ryan found a correlation of r = 0.76 [4]. Several factors have been shown to influence age perception accuracy to some extent, among them listener age [5], speaker age [2], the difference between the two [1], and listener sex. [6] There is evidence from speech production experiments which suggests that physiological condition may also be an important factor in perceiving the ageing voice [7, 8]. Speakers who were in good health were found to have younger-sounding voices.[9]

Cigarette smoking is definitely a factor which will not only affect physiological condition in general but also cause histological changes in the vocal apparatus. Despite well-documented effects on the vocal cords[10], there is a striking paucity of studies approaching the subject from an acoustical point of view, and these have all focused on Speaking Fundamental Frequency (SFF) [11,12, 13]. Generally, the F0 values for the non-smokers were found to be higher than those for the smoking group.

For the present study, the following questions were of interest: (i) whether or not a speaker's smoking habits influence his perceived age; (ii) which acoustic variables are good predictors of perceived age; (iii) whether or not trained listeners are better at estimating a speaker's age than phonetically naive listeners. The last question points to a potential forensic application of this study: One of the elements in speaker profiling, i.e. the analysis of an anonymous voice, is the assessment of a speaker's age group. It would be interesting to see whether this is done more reliably by phoneticians than by untrained listeners.

PROCEDURES

The recordings as well as the production data used in this study were available from a previous investigation [14]. Specifically, a total of 40 normal-speaking male subjects, 20 of them being smokers and 20 non-smokers, provided speech samples. Smokers ranged in age from 27 to 59 yrs with an average of 41.05 yrs (SD = 9.18). They had been smoking for an average of 21.4 yrs (range: 10-40 yrs; SD = 8.3). The average number of cigarettes smoked per day was 27.5, ranging from 20 - 40 (SD = 6.2). The non-smokers were between 25 and 58 years of age with a mean of 40.48 yrs (SD=10.89).

Subjects were first asked to read a standardized text (German version of „The North Wind and the Sun") which took approximately 45 sec. They then phonated the vowel /a:/ as steadily as possible for at least 3 sec at a comfortable pitch and loudness level. Only the text was used in the perception experiment.

Listeners

Two panels of listeners took part in the perception experiment. Group I consisted of twelve phoneticians, eight of them men and four women, who had extensive experience in the forensic analysis of anonymous voices. The age range for this group was 29-62 with a mean of 40.7. Group II consisted of 19 university students with no particular training in auditory phonetics. This group ranged in age between 20 and 32 years (mean: 23.3). All listeners reported normal hearing.

The text passages read by the 40 speakers were randomized and presented to the two panels of listeners through a high-quality recorder-speaker system in a quiet room. Listeners were informed that all speakers were male adults. They were instructed to listen to each sample and make a direct age estimation for each speaker.

RESULTS AND DISCUSSION

A production study had been carried out on the basis of the same data [14], investigating the following variables: speaking fundamental frequency, jitter, shimmer, and harmonics-to-noise ratio (HNR). For the purpose of the present study, syllable rate was measured in addition because there are findings which indicate that this parameter forms an important clue for listeners [3, 15]. The production study on the data used here revealed that shimmer and HNR were more effective in discriminating the two groups than speaking fundamental frequency and jitter.

The results of the listening experiment are summarized in Table 1:

Table 1: Means and standard deviations of speakers' average chronological age and the age perceived by the two listener groups

speaker group	chron. age	s.d.	perc.age$_{exp.}$	s.d.	perc.age$_{non\text{-}e.}$	s.d.
all speakers (N=40)	40.77	9.94	41.37	9.59	40.59	11.06
smokers (N=20)	41.05	9.18	44.14	10.64	43.79	12.12
non-smokers (N=20)	40.48	10.89	38.60	7.71	37.40	9.11

An analysis of variance was carried out on the differences between the estimated and the calendar age of the 40 speakers. The ANOVA was of the 'repeated measures' type, with one between-subject factor: the two listener groups, and one within-subject factor: smokers vs. non-smokers. Only the second factor turned out to be significant: $F(1,29) = 112.84$, $p < 0.001$. This means that the calendar age of the smokers was overestimated by both groups of listeners, and that of the non-smokers was underestimated. This finding seems to be in line with findings reported by Ringel/Chodzko-Zajko [9] pertaining to speakers who are in good physiological condition. Even though we did not test the physical fitness of our speakers, it seems fair to assume that smokers of the type recorded here (i.e. at least one pack per day for a minimum of 10 years) be in less than perfect health.

Furthermore, statistical analysis (Pearson correlation; one-tailed) reveals high correlations between speakers' cal-

endar age and perceived age for the trained (r = 0.699) as well as the untrained (r = 0.680) listeners ($p < 0.001$ for both). This basically supports the results reported in previous studies, although the correlation is not quite as high. Looking at both groups of speakers separately, it emerges that the correlations between perceived age and chronological age are much higher for the smokers than for the non-smokers in both listener groups (0.892 and 0.572, respectively, for the expert group, and 0.903 and 0.518, respectively, for the student group). A possible explanation for this finding is that the degenerative process in the larynx which is induced by smoking may have served as a cue for listener judgements. In order to investigate this question further, the correlation between smokers' chronological ages and the number of years for which they had been smoking was calculated. The result is 0.907, which demonstrates that the older smokers in this study have also smoked for a longer period of time. This finding is confirmed by the calculation of a partial correlation between calendar age and perceived age in which the factor "smoking time" was factored out. In this case, correlations between chronological age and perceived age drop to 0.650 for the expert group and 0.577 for the student group. These results suggest that duration of smoking has a distinct influence on listener judgements and largely contributes to the higher correlation for smokers. This finding indirectly supports the results of a study by Ramig/Scherer/Titze [7] which is the only one in which listener judgements did not correspond to the chronological ages of speakers. The authors explain this result by the fact that their speakers were specifically chosen to have good physical condition and that "These age ratings may have been related to listeners' expectancies of age-related characteristics of voice" [p.6]. In other words: listeners judge biological age rather than chronological age, and as soon as these two do not run parallel in a speaker, listeners can no longer resort to stereotypes, and their estimates become less systematic.

No statistical difference with regard to the correlations was found between the performances of the two listener groups, i.e. the expert listeners did marginally but not significantly better than the naive listeners. The same applies to the overall correctness of the judgements. The average difference between perceived age and chronological age was 6.5 years for the non-experts and 5.9 for the expert group. Both groups were more correct about estimating smokers' ages than those of non-smokers, the experts erring by 4.7 and 7.1 years, the naive listeners by 4.7 and 8.4 years respectively. This is well within the margin which is usually given in a forensic report. A possible explanation for the lack of a difference between the groups is that the design of the listening experiment was very different from forensic real-world conditions in several respects. There is also the possibility that age estimation is a task which does not require phonetic, let alone forensic phonetic skills but is based instead on the everyday experience (or even: stereotypes) of any listener within a speech community.

Regression analyses were carried out with chronological age and perceived age as dependent variables in order to investigate which production parameter would best explain the results. The following predictors were examined: F0, jitter, shimmer, HNR, and syllable rate. Of these, only syllable rate and HNR proved to be significant predictors for both calendar age and perceived age (5%-level). This finding supports previous research [3, 15] where "rate of reading" was found to be among the most efficient predictors of perceived age. Here, it was also found to predict chronological age. HNR has not been studied as a predictor for perceived or calendar age, but the results obtained here are no surprise in view of the fact that HNR is a good indicator of various voice pathologies [16].

With regard to the questions asked at the outset of the study it can be concluded that smoking does in fact affect age estimation in that smokers are judged to be significantly older than non-smokers of the same age. Furthermore, listeners can be demonstrated to make systematic use of the variable "smoking time" in order to assess the chronological age of a speaker. Syllable rate and HNR constitute the only variables with significant value as predictors for age estimation.

The finding that perception seems to be geared to biological age rather than chronological age has implications for age estimation in the forensic domain, because there, obviously, the latter is called for. Thus, it is advisable to use utmost care and to indicate an age span or even only general descriptions like "very young", "middle-aged" etc. rather than attempting direct age estimates for forensic purposes

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