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; Neuman/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 phoneticians, 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 recording-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 based 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>
<thead>
<tr>
<th>speaker group</th>
<th>chron. age</th>
<th>s.d.</th>
<th>perc. age</th>
<th>s.d.</th>
<th>perc. age</th>
<th>s.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>all speakers</td>
<td>(N=40)</td>
<td></td>
<td>40.77</td>
<td>9.94</td>
<td>41.37</td>
<td>9.59</td>
</tr>
<tr>
<td>smokers</td>
<td>(N=20)</td>
<td></td>
<td>41.05</td>
<td>9.18</td>
<td>44.14</td>
<td>10.64</td>
</tr>
<tr>
<td>non-smokers</td>
<td>(N=20)</td>
<td>40.48</td>
<td>10.89</td>
<td>38.60</td>
<td>7.71</td>
<td>37.40</td>
</tr>
</tbody>
</table>

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 underestimated by both groups of listeners, and that of the non-smokers was overestimated by both groups of listeners. The ANOVA was significant for both sexes, with the latter showing a stronger effect. 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
tained (r = 0.699) as well as the un-
trained (r = 0.680) listeners (p < 0.001
for both). This basically supports the
results reported in previous studies, al-
though the correlation is not quite as
high. Looking at both groups of speakers
separately, it emerges that the correla-
tions 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 explana-
tion for this finding is that the degener-
ative process in the larynx which is induced by
smoking may have served as a cue for
listener judgements. In order to investi-
gate 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 res-
ults suggest that duration of smoking
has a distinct influence on the 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 judg-
mements 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 judg-
ments. 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 ex-
erts erring by 4.7 and 7.1 years, the
naive listeners by 4.7 and 8.4 years re-
spectively. This is well within the margin
which is usually given in a forensic re-
port. A possible explanation for the lack of
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 es-
timation is a task which does not require
phonetic, let alone forensic phonetic
skills but is based instead on the every-
day 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 fol-
lowing 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 pre-
vious 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 es-
timation 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 consti-
tute the only variables with significant
value as predictors for age estimation.

The finding that perception seems to be
gained to biological age rather than
chronological age 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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