Has the Prevalence of Creaky Voice Increased Among Finnish University Students From the 1990′S to the 2010′S?

*Tuuli Uusitalo, *Laura Nyberg, *Anne-Maria Laukkanen, *,†Teija Waaramaa, and *Leena Rantala, *Tampere, and †Vaasa, Finland

Abstract: Everyday observations indicate that creaky voice has become common in Finland in recent years. Previous studies suggest that this trend is also occurring in other countries. This cross-sectional study investigates the use of creaky voice among Finnish university students from the 1990′s to the 2010′s. Material was obtained from a sound archive. It consisted of 200 samples from normophonic speakers (95 males, 105 females; mean age 23.7 years, SD 3.3 years, range 19−35 years). Normophonia was checked by two speech therapists in a preliminary perceptual analysis. Thereafter, two voice specialists rated the amount of creak and strain. A scale of 0−4 was used (0 = none, 4 = a lot). The inter- and intrarater reliability for the listening evaluations were satisfactory (for creaky phonation, rho = 0.611, $P < 0.001$ for interrater reliability and rho = 0.540, $P < 0.001$ for intrarater reliability; for strain, rho = 0.463, $P < 0.001$ and rho = 0.697, $P < 0.001$ for inter- and intrarater reliability, respectively). These results revealed a significant increase in the amount of perceived creak in females (from 1.04, SD 0.69 to 1.55, SD 1.06; $P < 0.05$, Mann-Whitney U test). In males, no significant change was found. However, the frequency of creaky voice use increased in both genders. No male speakers from the 1990′s were rated as using "a lot" of creaky voice, but 2.3% of male speakers from the 2010′s received this rating. Male speakers who were rated "quite a lot" increased from 5.9% in the 1990′s to 18.1% in the 2010′s. Female speakers rated "a lot" increased from 0% to 6%, and female speakers rated "quite a lot" increased from 7% to 25.8% over the studied time periods. Creaky phonation and strain correlated slightly in males (rho = 0.24, $P < 0.05$) and moderately in females (rho = 0.55, $P < 0.001$). Age did not correlate with the amount of creaky phonation (rho = 0.005, $P > 0.10$ for males, rho = -0.011, $P > 0.10$ for females). It can be concluded that the prevalence of creaky voice has increased among young Finnish speakers, particularly females.

Key Words: Vocal fry−Creaky phonation−Voice quality−Strain−Perceptual evaluation.

INTRODUCTION

Multiple terms are used to describe rough vocal qualities that are not related to dysphonia but may occur in anyone's voice and speech. These terms include vocal or glottal fry, creak, strohbass, and pulse register.[1] Pulse register or vocal fry has been related to low pitch and low subglottic pressure.[2-7] During this type of phonation, the vocal folds are short, thick, and strongly adducted. Medialization of the false vocal folds is often included. The vocal folds vibrate at a small amplitude, and the closed phase of the glottis is long.[3,7] Creaky voice, in turn,[8] may have a higher perceived pitch but a raspy quality due to aperiodicity or the inclusion of vocal fry. Keating, Garellek, and Kreiman (2015) have described six different types of creak: prototypical creaky voice, vocal fry, multiple pulsed voice, aperiodic voice, non-constricted creak, and tense and/or pressed voice.[9] These varying types have different acoustic properties, none of which describe all subtypes.

Creak has traditionally been related to voice disorders since it often correlates with abnormal laryngeal function.[10] Clinical findings have linked creak with hyperfunctional voice use, symptoms of vocal fatigue, and contact granulomas.[11-13] However, all types of creaky phonation may also be used in normal speech. They may serve linguistic and communicative purposes such as characterizing phonemes, differentiating between words,[14-15] marking phrase endings or turn taking,[16,17] or expressing attitudes or emotions (eg, boredom).[18,19] A previous study by Laukkanen and Rantala[20] found no correlation between vocal symptoms (VHI) and the amount of creaky phonation. This finding, however, may be tentatively explained by the assumption that the participants (young students) either did not use their voices very much or were not sensitive to signs of vocal fatigue.

Previous literature indicates that the use of creaky phonation in normophonic speakers is very common and is even showing a tendency to increase.[10,21-27] Some researchers report that the prevalence of creaky phonation has increased among young English-speaking women.[23-25] This also seems to be controversial; some studies suggest that that creaky voice has a strong negative effect on perceptions of a speaker, especially if the speaker is a young female person.[28] People who use creaky voice may be judged more negatively than people who do not use creak.[29-32] Creaky voice is rated as less natural, and it requires more concentration from the listener than non-creaky voice. It may also negatively impact a listener's rating of a speaker's employability.[28,30] In addition to impacting the listener's impression of a

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From the *Speech and Voice Research Laboratory, Faculty of Social Sciences, Tampere University, Tampere, Finland; and the †Communication studies, School of marketing and communication, University of Vaasa, Vaasa, Finland.

Address correspondence and reprint requests to Tuuli Uusitalo, Speech and Voice Research Laboratory, Tampere University, Virta Building, Åkerlundinkatu 5, 33100, Tampere, Finland. E-mail: tuuli.uusitalo@tuni.fi

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speaker, creak may also affect negatively message transfer by consuming more cognitive capacity and loading listeners' working memory more than regular voice.[33]

Although results from several studies suggest that the prevalence of creaky phonation has increased, a systematic review was not able to confirm this conclusion, at least concerning young American women's speech.[34] Instead, the prevalence of creaky voice use varied in the 10 studies included in the review.[34] Possible causes of this variation include the small number of participants, short duration of speech samples, and different test methods.

In Finland, teenagers of both genders have been reported to use a large amount of creaky phonation.[26,27] Härkönen found that 14-year-old participants exhibited creaky phonation 14−43% of their speaking time.[26] Ketolainen et al. found that approximately 60% of boys and 98% of girls (aged 16 −17 years) used creak in their speech.[27] Creaky phonation has also been reported in female teachers, some of whom may use it in up to 54% of their speech.[35] A recent study of Finnish female students[20] found a 73% prevalence of slight to moderate creak. Perceived strain was also common; slight to moderate strain reached a prevalence of 88.5%.

Everyday observations suggest that the use of creaky voice has increased among Finnish speakers in recent decades, but, so far, this topic has not been investigated in a large number of participants. This cross-sectional study uses a sound archive to investigate the prevalence and degree of perceived creak and strain among male and female Finnish university students from the 1990′s and the 2010′s.

MATERIAL AND METHODS

Participants and recordings

Material was obtained from the sound archive of the Speech and Voice Research Laboratory at Tampere University. It consisted of texts (duration 40−80 s) that were read aloud and recorded by Finnish university students in the 1990′s and 2010′s. The recordings were made in a well-damped studio using a 44.1 kHz sampling rate and16-bit amplitude resolution. In the 1990′s, the microphone was a Bruel and Kjaer 4165, and in the 2010′s it was Bruel Kjaer Mediator 2238. The mouth-to-microphone distance was 40 cm. The recordings were made before a primary voice and speech class to determine the status quo of each student. Participants were asked to read a text aloud using their habitual conversational volume and to read neutrally, without any particular emotional or artistic expression. For this study, text samples from 236 readers aged 19−35 years were chosen for preliminary perceptual analysis; these samples were checked for normophonia. The choice of samples was thus systematically random. One speech and language pathologist with 30 years' experience evaluated the samples using the G from the GRBAS scale.

Listening evaluation

Two voice specialists (the same SLP who evaluated the samples for normophonia and another voice scientist and speech trainer, also with 30 years of experience) evaluated the randomized samples for the amount of creaky phonation and strain. A scale of 0−4 was used to rate the samples (0 = not at all, 1 = a small amount, 2 = a moderate amount, 3 = quite a lot, 4 = a lot). The raters listened to the samples with headphones for the evaluation (Sony MDR-V700 and Bose QuietComfort 35). The raters could repeat each sample as many times as they wanted. The evaluation was performed twice to measure the intrarater reliability of the ratings.

Acoustic analysis

In order to shed light on the relationship between the fundamental frequency and the prevalence of creaky voice, the *fo*-analysis results were correlated with the mean ratings for creaky phonation. The *fo* -analysis results for 103 female participants (of a total of 105) were obtained from a previous study.[36] The analysis was conducted using Praat software (5.4.05). The time window for the analysis was 0.01 s, and the autocorrelation method was used. The range for *fo* detection was 130−415 Hz. The performance of the automatic *fo* detection was checked manually. The mean and median for *fo* were calculated.

Statistical analysis

The inter- and intrarater reliabilities of the perceptual ratings were investigated using Spearman's correlation. The normality of distribution in the parameters was checked using the Kolmogorov-Smirnov test. The relationships of mean ratings for creaky phonation with age and *fo* and the relationships between the ratings for creaky phonation and strain were examined using Spearman's correlation. A Mann-Whitney *U* test was used to compare creaky phonation ratings for the recordings from the 1990′s with those from the 2010′s. The samples were classified into low, average, or high pitch using mean *fo* values; they were also divided into two categories based on the creaky phonation ratings: "none or a little" versus "moderate or a lot." The differences in the mean *fo* for these two categories were examined using cross-tabulation, chi-square tests, and the Mann-Whitney *U* test. The relationship between the text that was read (N = 3) and the mean ratings for creaky phonation were examined using the Kruskall-Wallis test. SPSS (version 27; IBM Statistics) was used for the statistical analyses.

RESULTS

GRBAS evaluation

Some samples failed the GRBAS test because they had G values of 0.5−1; these samples were excluded. This left a total of 200 samples (95 males, 105 females; mean age 23.7 years, SD 3.3 years, range 19−35 years). The material included 91 samples from the 1990′s (40 females, 51 males) and 109 samples from the 2010′s (65 females, 44 males). The samples were recorded from 1990−1995 and from 2010 to 2019. Most texts consisted of a 162-word extract from the novel *Moreeni* by Lauri Viita. Eighteen male participants

from the 2010′s (out of 45) recorded the text *Pohjantuuli ja aurinko*, a 77-word selection from the Finnish translation of "The North Wind and the Sun." Three participants read an 81-word extract from the Finnish translation of William Saroyan's *The Human Comedy* (see Appendix for all texts). The archive did not include many recordings of male students from the late 2010′s, and thus, in order to include a sufficient number of samples, we had to use recordings of multiple texts.

Evaluation of creak and strain

The interrater reliability analysis yielded the following results: rho = 0.611, $P < 0.001$ for creak and rho = 0.463, $P < 0.001$ for strain. The results for intrarater reliability were rho = 0.540, $P < 0.001$ for creak and rho = 0.697, $P < 0.001$ for strain. Since the inter- and intrarater reliabilities were judged to be satisfactory, the means of the creak and strain ratings were calculated. These average values were used for further statistical analyses.

As the mean values for creak and strain did not follow a normal distribution (Kolmogorov-Smirnov test, $P = 0.000$), the non-parametric Mann-Whitney *U* test was used to measure differences between the mean ratings for samples from the 1990′s and those from the 2010′s.

Table 1 compares the mean ratings for creak for the samples from the 1990′s and the 2010′s. The results reveal a significant increase in perceived creak in females. In males, the change was not statistically significant, but an increasing trend in creak could be observed in the samples of male speakers as well (Table 2). While the number of mean ratings of "no creak" or "a moderate amount of creak" decreased in both genders, the number of ratings of "moderate," "quite a lot," and "a lot" increased. Figure 1 shows the distributions of the mean ratings. Age did not correlate with the amount of creak. For the data recorded in the 1990′s, rho was 0.097 ($P = 0.498$) for male participants and -0.044 ($P = 0.779$) for female participants. For the voice samples from the 2010′s, rho was -0.140 ($P = 0.416$) for the males and -0.030 ($P = 0.810$) for the females.

Some correlations were found between the ratings for creak and strain, particularly in females. The results were as follows: In the voice samples collected in the 1990′s, rho was

TABLE 1.
Comparison of the Perceived Amount of Creaky Phonation (scale 0–4) in Text Readings Recorded in the 1990′s and the 2010′s (Mann-Whitney *U* test)

Amount of creaky phonation	1990′s	2010′s	*P* value
Males			
mean	0.96	1.12	1.00
SD	0.72	1.05	
Females			
mean	1.04	1.55	0.03
SD	0.69	1.06	

Note: Scale: 0 = not at all, 4 = a lot

TABLE 2.
Frequency Distribution of Ratings of Creaky Phonation in the Voice Samples From the 1990′s and 2010′s.

	Males		Females	
	1990′s	2010′s	1990′s	2010′s
>0≤2	94.1%	79.6%	93 %	68.2%
>2≤3	5.9%	18.1%	7%	25.8%
>3≤4		2.3%		6%

Source: Creaky Phonation was evaluated using the scale 0–4. Mean values were calculated from the evaluations of two raters.
Note: Scale: 0 = not at all, 1 = a small amount, 2 = a moderate amount, 3 = quite a lot, 4 = a lot

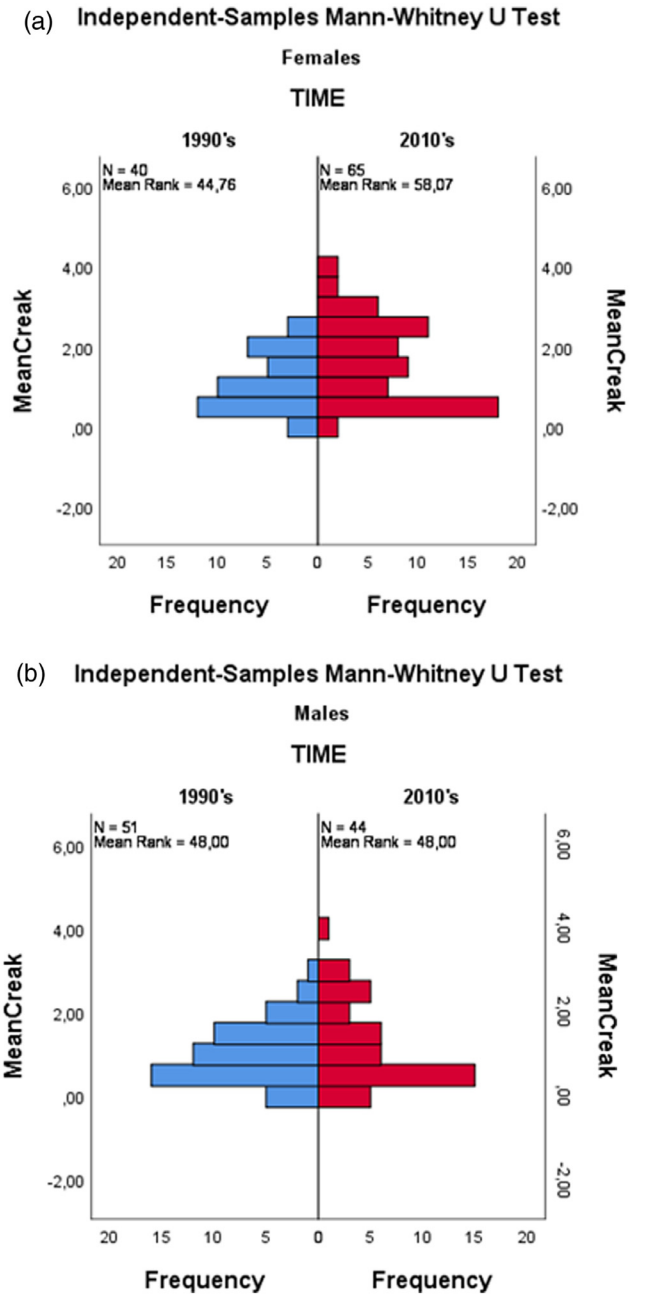

FIGURE 1. Distribution of mean perceptual ratings of creak (scale 0–4; 0 = not at all, 4 = a lot) for females (A) and males (B) from the 1990′s and 2010′s.

TABLE 3.
Cross-Tabulation of Mean Ratings of Creaky Phonation in the Present Study and Mean *fo* of Text Reading Samples From 103 Females From the Study[36]

Amount of creaky phonation	< 180 Hz	180 Hz - 214 Hz	> 214 Hz	Total
0-1	6	25	21	52
> 1	7	31	13	51
P value (Chi-Square)		0.27		

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.593*	2	0.274
Likelihood Ratio	2.612	2	0.271
Linear-by-Linear Association	1.794	1	0.18
N of Valid Cases	103		

* 0 cells (0.0%) have an expected count under 5.
Source: Classes of Creaky Phonation: "none or a little" = mean ratings 0 −1; "moderate to high amount" = >1−4. Classes of Mean *fo*: low *fo* = <180 Hz, Average *fo* = 180−214 Hz, High *fo* = >214 Hz
Notes: The minimum expected count is 6.44.

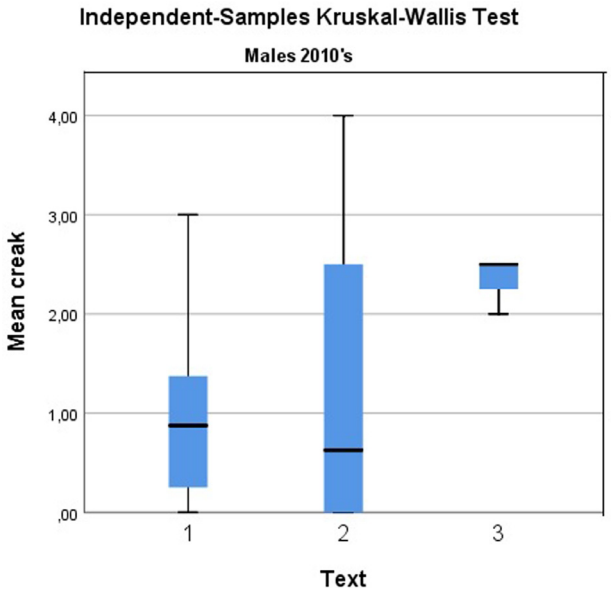

FIGURE 2. Mean ratings of the amount of creaky phonation according to text read in the sample. N = 45 in total; n for text 1 = 24; n for text 2 = 18; n for text 3 = 3. Text 1 has 162 words, text 2 has 77 words, and text 3 has 81 words.

0.618 ($P < 0.001$) for females and 0.156 ($P = 0.276$) for males; in the 2010′s, rho was 0.471 ($P < 0.001$) for females and 0.325 ($P < 0.05$) for males.

Creaky phonation vs. mean fo

The mean ratings for creaky phonation did not correlate with either the mean *fo* or the median *fo*. Spearman's rho was -0.075 ($P = 0.452$) for the mean *fo* and -0.104 ($P = 0.294$) for the median *fo*. Cross-tabulation and chi-square test results for three pitch classes (low, average, and high) and two categories of creaky phonation ("none or a little" and "moderate or high") are shown in Table 3. Table 4 shows that the mean *fo* for the two classes of creaky phonation did not differ, as measured by a Mann-Whitney *U* test.

TABLE 4.
Mann-Whitney *U* Test Results Comparing Mean *fo* in Samples With "no or a little creaky phonation" to That in Those with "a moderate to high amount of creaky phonation."

Independent-Samples Mann-Whitney *U* Test Summary	
Total N	103
Mann-Whitney *U*	1258.000
Wilcoxon W	2584.000
Test Statistic	1258.000
Standard Error	151.558
Standardized Test Statistic	-.449
Asymptotic Sig.(2-sided test)	.654

Effect of text

Approximately half of the males in the 2010′s read different, shorter text extracts than the other participants (see Appendix for the three texts). The Kruskall-Wallis test was used to measure whether the amount of creaky phonation was related to the text in the sample. The result was non-significant ($P = 0.173$). Figure 2 illustrates the distribution of mean ratings by text. The figure shows that the type of the text had no systematic relation with the perceptual evaluation. More specifically, shorter texts were not evaluated to have less creaky phonation than the longest text.

DISCUSSION

This study investigated the prevalence and degree of perceived creak and strain among male and female Finnish university students. The voice samples were recorded in the 1990′s and the 2010′s. The results show that creak as a phenomenon is related to normophonic speech and that the prevalence of creaky voice among young Finnish speakers, particularly women, has increased in the last two decades. In the present study, interrater reliability was somewhat higher for female than male voices. It may be that creak is more difficult to identify in low-pitched male voices. On the other hand, sufficiently low *fo* and creak may be somewhat identical concepts.[37] However, there was no correlation between mean *fo* (or median *fo*) and perceived amount of creaky phonation. The samples of male speakers from the 2010′s included three different texts. This is, however, unlikely to affect the results since all readers were instructed to read the text neutrally, without any emotional or artistic expression. The perceptual impression of creaky voice is

also very similar for all texts. One might speculate that a shorter text would include less use of creaky voice than a longer text. However, no such relationship was found between the texts and the perceived amount of creaky phonation in the present material.

Few studies have compared the prevalence of creak in males and females, and the results of previous research on this topic differ from ours. One study from Britain in the 1980′s reported that men use creak three to ten times more frequently more than females.[16] A similar and statistically significant finding was made for Estonian speakers in the 2010′s, although the difference between the genders was not as large as in the British study: males used creak 13% of speaking time and females in 10% of speaking time.[38] On the other hand, our results align with those of previous studies that included only female participants. The outcomes of such studies[10,23] suggest that creak is indeed common among women, at least in the United States.[10,23]

Women also seem to favor lowered *fo*, which has been interpreted to reflect an attempt to sound more convincing.[39-41] Increased creak could therefore be associated with lower *fo*.[42] The mean *fo* in speech naturally declines when glottal fry increases, at least if the lowest *fo* values are not excluded from the analysis.[36] A previous study found that mean *fo* of young Finnish women had significantly risen from the 1990′s to the 2010′s.[36] Those researchers suggest that this could result from the influence of other languages, mainly English, and of the global entertainment business. In that case, this increase in *fo* should also be observed in males. However, a recent study of young Finnish male speakers shows no significant increase in *fo*.[43] Therefore, higher *fo* in Finnish females calls for another explanation.

Another possible explanation for the increased amount of creak found in the present study may be speakers' attempts to ease phonation. Creak may be produced with low subglottic air pressure and airflow[44] and thus does not require recruitment of the larger respiratory muscles; instead, it mainly involves using the small adductory muscles to damp vocal fold vibration.[45] Increased creak may also be due to cultural trends and habits. For example, the use of minimal lung volume can be related to speaking posture. Prolonged use of devices like smartphones may negatively affect posture and respiratory function.[46] The trend of increased creak may also stem from communicative aspects: creak has been related to boredom and/or relaxation[18,19] and informal speech.[38] During conversations, people modulate their vocal patterns to match those of their conversational partner. This increases efficiency and both partners' enjoyment of the interaction.[21] Creak has also been reported to be a marker of membership in socials groups.[8] For instance, it has been reported as a sign of membership in particular gangs.[47] Creak, thus, may be a way of increasing "street cred."

In the present study, all samples consisted of text readings. This raises the question of how closely reading aloud corresponds to spontaneous speech. Earlier studies have reported that females use creak in official speech to gain credibility. However, more recent results have linked the use of creak with informal speech.[21,22,38] In that case, it could be expected that if creak is common in reading aloud, which is a somewhat formal situation, it would very likely be even more prevalent in informal speech. This is also our everyday impression, but further research is needed to confirm it.

We measured the perceived amount of creak in this study since the automatic detection of creak in speech signals is challenging.[48] Additional studies are needed to investigate the relationship between perceived creak and the percentage of creak in the speech signal. This relationship is hardly linear, as perception may be affected not only by the actual amount of creak (eg, the percentage of creaky segments in the total length of the voiced segments in a sample), but also by the perceptual prominence of the creaky segments. This, in turn, may vary according to the volume of the creaky segments or their location in the sentences.

CONCLUSIONS

The results of this study indicate that the perceived prevalence of creaky voice among young Finnish women has increased significantly in the last two decades. A trend of increased creaky voice use was also observable in males, but this difference was not statistically significant. Further studies should examine the use of creak longitudinally to establish the longevity of this habit as speakers age and mature.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at doi:10.1016/j.jvoice.2021.12.006.

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