TRACKING CREAK FROM EARLY TO LATE ADULTHOOD: A PANEL STUDY FROM THE NORTH EAST OF ENGLAND

James Grama, Mirjam E. Eiswirth, & Isabelle Buchstaller

Sociolinguistics Lab, University of Duisburg-Essen
james.grama@uni-due.de, mirjam.eiswirth@gmail.com, isabelle.buchstaller@uni-due.de

ABSTRACT

This study investigates how creak and F0 change across the life-span in a panel of six English speakers from the North East of England, recorded between two and three times. Across timepoint, we observe a general decrease in F0 for all but one speaker. However, creak follows complex patterns as speakers age. In early adulthood, all speakers exhibit creak, and show evidence that creak can be recruited to indicate turn-finality. Towards the end of their working lives, speakers reduce their proportion of creak dramatically, and show little evidence of its previous turn-yielding function. In older age, creak reappears, and a subset of speakers show renewed use of its turn-yielding function. These findings suggest that both global and interactional uses of creak change over the life-span, and suggest that—for some communities—creak may be age-graded.

Keywords: lifespan change, panel study, creaky voice, F0, North East of England.

1. INTRODUCTION

This paper explores the use of creaky voice across a small panel sample of speakers. As a highly multiplex phonation type, creak is contingent on both physiological and social-interactional factors. Here, we explore its use by six English speakers from the North East of England who were interviewed once in early adulthood, and either one or two times in older age. We ask: (1) do we observe age-related changes in fundamental frequency (F0) and creak; and (2) do speakers vary in their use of creak as an interactional strategy to signal turn-transition?

Our analysis suggests that in early post-adolescent life, speakers make frequent use of creak, especially at the end of turns; however, the rate of creak and its turn-final use decrease across the middle life-span. Following retirement, speakers show a general resurgence in creak, both as a global feature and especially as a turn-final indicator.

1.1. Life-span change and creak

While linguistic theory tends to rely on the observation that speech patterns are relatively fixed by adulthood [1], panel studies (which follow the same individual over time) have revealed post-adolescent malleability (see [2]). Voice quality would appear to lend itself particularly well to panel studies, given that it has been characterized as a semi-permanent feature of individuals [3], despite the age-related changes that affect laryngeal structures (e.g., vocal fold atrophy [4], histological changes [5], and changes in glottal competence [6]). In elderly populations, these physiological changes partly motivate increased irregularity in F0, jitter, and shimmer (e.g., [7]). Particular focus has been placed on changes in F0, which has been found to decrease as speakers age, followed by an increase in elderly men, and a decrease in elderly women [8-11]. Given the relationship between low F0 and creak [12], we might expect creak to parallel changes in older age; however, we are not aware of any panel research that explores changes in creak across the adult life-span.

1.2. Social and stylistic functions of creak

Creak has shown to be highly multifunctional in conversation, indexing both social information about the speaker, as well as doing interactional work [13]. Creak's frequent occurrence in turn-final position in English and Finnish suggests a turn-completion signalling function [14-15]. As a global feature, creak is both used in greater proportion by [16-20] and heavily associated with young, urban, college-educated women [16, 20-21]. From the perspective of language change, there are two possible explanations for this pattern: (1) we could be seeing a change in progress led by this group (as suggested by [16] for English); or (2) creak could be an age-graded feature. The latter hypothesis finds some support in the distribution of creak in early studies [22-23], which similarly find that creak is used more by young women. This suggests the possibility of a repeated pattern at the individual level, while the community as a whole remains stable.

What is thus needed is a panel study that explores changes in both the extent of overall creak, as well as how speakers operationalise creak in interaction across the life-span. We begin to address these questions here, focusing on malleability in F0 and in creak, both globally and as an interactional resource across the adult life-course of six individuals.

2. METHODS

2.1. Panel data-set

The data come from sociolinguistic interviews conducted with the same participants in 1971, 2013, and 2019. These speakers (see Table 1) offer a rich picture of the linguistic choices made by individuals as they transition from young adulthood to the end of their professional careers and into older age; we argue that these trajectories carry more weight than treating age as purely chronological [24-25].

Sex	Speaker	YOB	T1	T2	T3
F	Edith	1939	32	74	--
	Nelly	1942	29	71	78
	Anne	1948	23	65	71
M	Aidan	1946	25	67	--
	Rob	1948	23	65	--
	Fred	1950	21	63	69

Table 1: Panel participants and ages by time point.

2.2. Preparing the data and delineating a 'turn'

Interviews were transcribed and time-aligned using ELAN [26]; speech intervals were divided into sections delineated by pauses, roughly falling into 'breath groups'. Transcriptions were force aligned using LaBB-CAT [27], a process that created smaller .wav files based on aligned intervals (*n*=10,012).

We make use of the conversation analytical concept of a "turn" [28-29], which we define (following established practice) as a spate of talk produced by one participant when they are holding the floor. Because turns are delimited following interactional parameters (i.e., floor transition), their length is not predetermined, though they tend to contain no more than a few turn-constructional units [30]. We restrict our analysis to turns where floor transition is unproblematic (i.e., non-competitive [31]; *n*=2,156 turns).

2.3. F0 extraction and creak assessment

Though creak is notoriously multiplex [32], Keating et al. [12] argue that one of its prototypical features is low or irregular F0. Without intending to wash away inherent complexities, we operationalize low F0 here as a correlate of creak. This approach has been reliably implemented in [33], who use REAPER (the Robust Epoch and Pitch EstimatoR; [34]) to identify likely creak. REAPER produces estimations of Glottal Closure Instants (GCIs), from which F0 can be estimated by taking the reciprocal of the duration between adjacent GCIs. REAPER's default settings were used, but to prioritize detection of low F0, minimum expected F0 was lowered from 40 to 20 Hz. We excluded overlapped segments, resulting in 2,006,501 F0 measurements across 15 recordings.

Creak was estimated using binary categorization of F0 measurements (see [33]). The mode of F0 values was calculated for each recording, as well as the most prominent mode below this mode; the antimode between these two modes was calculated, and all values below this antimode were coded as creaky. Given reported age-related changes to F0, this categorization was done for each recording to produce individualized pictures of a speaker's F0 and creak at each timepoint. Of the total F0 measurements, 95.2% (*n*=1,910,850) were classified as modal, and 4.8% as creaky (*n*=95,651).

We present three analyses: (i) of changes to F0, (ii) of global creak, and (iii) of creak over the duration of a turn. While claims can certainly be drawn from group-aggregated data, we echo [35] in arguing that such analyses can hide important speaker-specific changes which bear on life-span changes. Therefore, our analysis of F0 includes linear mixed-effects models fit to each speaker. The dependent variable was modal F0 (excluding creaky tokens), with timepoint as a predictor, and turn and word as random intercepts (Section 3.1). Changes to creak across the life-span and the turn (Sections 3.2-3.3) were modelled using logistic mixed-effects models fit to each timepoint separately, due to uneven representation of creak across recording. These models included an interaction between speaker and relative position in the turn, with a random slope of turn by relative position in the turn. Alpha for all models was 0.05.

3. RESULTS

3.1. F0 over the life-span

We turn first to an analysis of how modal F0 has changed over the life-span. First, we note a decrease in F0 across timepoint for all speakers (Table 2), with greater changes observed between T1 and T2 (where there is a larger time-gap) than between T2 and T3. Of the speakers with a third timepoint, only Anne shows significant F0 lowering between T2 to T3. In contrast to findings from [9-11], men in our sample show no evidence of an F0 increase in later life. Also, women tend to show numerically larger life-span changes in F0 than men; in fact, Rob shows no significant change across timepoint at all. Thus, while F0 decreases with age, the extent of these changes is highly speaker- and life-stage specific.

If we plot all F0 measurements (Figure 1), we observe a bimodal distribution for F0: women show a primary peak between 150-220 Hz, while men exhibit one between 80-130 Hz. We also note a second, low peak that represents the F0 of identified creaky tokens (between 80 and 100 Hz). This secondary peak shows considerable intra-speaker variance, being clear for some, and absent for others. This is early evidence that speakers show different extents of creak across their life-spans.

	Estimate (T1-T2)	Estimate (T1-T3)	Estimate (T2-T3)
Edith	-13.40 (***)	--	--
Anne	-27.47 (***)	-35.46 (***)	-7.99 (***)
Nelly	-48.79 (***)	-50.25 (***)	-1.46
Aidan	-8.39 (*)	--	--
Rob	-2.49	--	--
Fred	-9.93 (***)	-11.99 (***)	-2.06

Table 2: Estimated F0 differences (by speaker) across timepoint: (***)=$p<0.001$, (*)=$p<0.05$.

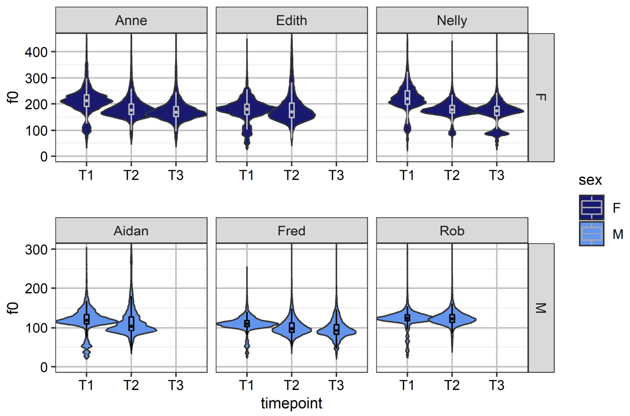

Figure 1: Distribution of F0 by speaker and timepoint.

3.2. Change in creak over time

Figure 2 shows the proportion of creak across time point and speaker. It demonstrates two things. First, while creak rates are generally low, all cohort members produce creak to some extent at T1, followed by a decrease in the amount of creak at T2. Three speakers (Edith, Fred and Aidan) produce no creak at all at T2. Second, all speakers with a third timepoint register an increase in their proportion of creak from T2 to T3. As with changes to F0, speakers vary in the extent to which their rates of creak increase; Anne and Fred show modest increases, while Nelly's rate rises to about 18% of all GCIs.

In the context of variability across the life-span, these findings suggest that speakers tend to exhibit more creak when they are young and relatively new members of the workforce (at T1), followed by a decrease in creak at or near the age of retirement (at T2). At T3, when speakers are well-and-truly retired from the workforce, they show an increase relative to T2. This pattern maps closely on to the U-shaped curve typical of age-graded variability, in which a middle-aged trough is followed by a tail (see [36]).

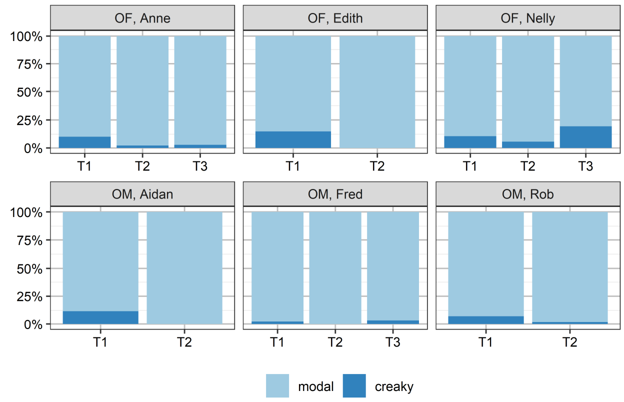

Figure 2: Proportion of GCIs coded as creaky (dark) vs. modal (light) across speaker and timepoint.

3.3. Creak across the turn

We now turn to an investigation of *where* creak is deployed in the turn, and whether this, too, changes over the life-span. Figure 3 shows the marginal effects from the models fit to timepoint, organized by speaker; normalized relative turn position is on the x-axis, with predicted creak on the y-axis.

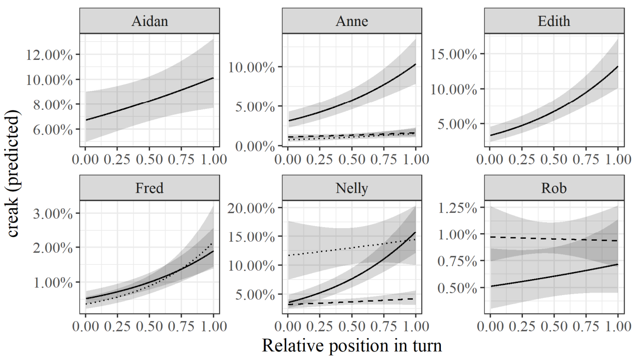

Figure 3: Predicted creak across time-normalized position in the turn for T1 (solid), T2 (dashed), and T3 (dotted); y-axis scaled to show individual behavior.

First, these findings corroborate that speakers exhibit vastly different overall rates of creak across timepoint. Second, creak use is mediated by turn position and timepoint. At T1, all speakers show a positive relationship between creak likelihood and turn position—that is, creak is more likely to occur at the end of a turn. However, the strength of this effect varies by speaker. All speakers show a significant effect of turn position (Table 3), except for Rob, whose use of creak is also relatively low. At T2, we observe a drastic change that corresponds with the global decrease of creak; no speakers exhibit a meaningful relationship between turn position and the likelihood of creak, even those with turn-mediated creak at T1. T3 reveals more heterogeneous patterns. Fred shows a resurgence of creak, both overall and in turn-final position. Anne, who showed creak at T2 with no effect of turn-position, exhibits the effect anew at T3, although less strongly than at T1. And Nelly, who mirrored Anne at T1 and T2, shows a significant global increase in creak at T3, but no relationship between creak and turn position.

	T1	T2	T3
Edith	1.493(***)	--	--
Anne	1.273(***)	0.380	0.740(*)
Nelly	1.632(***)	0.283	0.246
Aidan	0.450(*)	--	--
Rob	0.341	-0.036	--
Fred	1.311(***)	--	1.806(***)

Table 3: Estimated log-odds of turn position on creak; Šidák corrected *p*-values: (***)=$p<0.001$, (**)=$p<0.01$, (*)=$p<0.05$.

4. DISCUSSION

We can now start to paint a picture of how F0 and creak vary over the life-span in this panel of older speakers. First, we provide corroborating panel evidence that F0 does indeed lower in older age (cf. [8-11]), though without the rise shown by elderly men. While this could be explained by individual differences across studies, it is more likely that our men are simply not old enough to show this effect (all are at least 8 years younger than the mean age of elderly men in [9]). Second, while [3] argues that voice quality is a quasi-permanent feature of a person's speech, the current panel speakers exhibit differentiated and variable creak over their lifespans, behavior which appears to follow the classic U-shaped curve associated with age-grading in sociolinguistic theorizing [36]. High rates of creak among the women in the sample, especially at T1, supports research that links creak with young women's speech (despite studies also placing a disproportionate focus on this very group; see [20]). The decrease in the proportion of creak we observe at T2, thus, could be driven by increased pressures to avoid some of the indexicalities of this feature while the uptick at T3 would represent a relaxation of these pressures (cf. the lessening of marketplace pressures in old age; [35]).

Finally, creak's behavior throughout the turn provides additional insight into its function. At T1, when speakers are relatively young and just beginning their career trajectories, all show an increased likelihood for creak to occur at the end of turns. Presumably and as argued in [14-15], this is evidence of creak's turn-yielding function. At T2, however, this use all but disappears, paralleling the overall decrease in global creak. Again, it is possible that this change is due to the indexical association of creak as "young" and as a feature of women's speech (see [16]). Two of the three speakers who creak at all at T2 are women (Anne, Nelly), and all other speakers (except Rob, whose rates are low) avoid creak categorically. At T3, speakers exhibit variable patterns, with Anne and Nelly showing a resurgence in their use of creak, but in different ways. Anne demonstrates little change in overall proportion of creak, but makes renewed use of its turn-yielding function, while Nelly drastically increases her rate of global creak, which numerically but not statistically rises across the turn. Fred, by contrast, reproduces his behavior at T1, seemingly deploying creak as he once did after abandoning it at T2. These complex patterns indicate that creak is recruited for social as well as interactional uses which change over the life-span and suggests that changes in creak cannot be solely explained by changes in motor-control.

It is, of course, important to note the limitations of our study. REAPER has been shown to be a robust sociophonetic tool, but it is also a coarse-grained one [33]. Because our study relies heavily on the unsupervised identification of creak, it is likely that some differences exist between human coded creak and creak as coded by REAPER. In addition, the methodology applied here does not account for creak that is *not* characterized by low F0 (e.g., aperiodic creak; [12]). Verification of the observed patterns is therefore necessary to gain higher-resolution insight into how creak is operationalised across the life-span. In spite of these caveats, we believe our results point to the possibility that creak is partly an age-graded phenomenon.

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