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Frequency effects over the lifespan: a case study of Attenborough's r's

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Abstract:
This paper uses a small-scale case study of the speech of a single speaker at two points in time to investigate the question of whether and how speakers' mental representations change over their lives. Specifically, I test two predictions of usage-based models of phonological representation: that individuals surrounded by a changing community will show the community change in their own production, and that this individual-level change will show an effect of item frequency. The community change under study is the loss in English Received Pronunciation of [ɾ] as a realization of /ɹ/; the speaker studied is Sir David Attenborough, a well-known British nature documentary narrator. I find that Attenborough's narrations do not show evidence of him participating in the community change away from [ɾ] over time; however, he does show a different sort of change, by which he **increases** his rate of [ɾ] in high-frequency collocations in later life. I propose that this result may be attributable to Attenborough's mental representation of high-frequency collocations becoming more word-like over time. The results speak to questions about the malleability of mental representations and the role of the individual language user in cases of community change.

Keywords: language change across the lifespan, phonological representations, usage-based models, Received Pronunciation, sound change

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1 Introduction

Research over the past two decades has provided ample evidence that speakers can change some aspects of their native language after the critical period for language acquisition (see Sankoff 2005; Sankoff 2013 for two recent reviews). Despite this, we still lack answers to a number of questions about the phenomenon of later-life language change in a general sense. Chief among these are:

1. The "what" question: What kind of change in later life is possible? For instance, is later-life change more likely at a particular level of grammar, or with cases of variation that fit a particular social profile?
2. The "why" question: What causes linguistic change in later life to take place? To what extent can social and biological mechanisms be disentangled?
3. The "how" question: By what linguistic means is change effected? What aspects of speakers' mental representations change over their lives?

It is the third of these which I address in this paper, using a small-scale case study of a single speaker at two points in time. In the following section, I observe that different models of phonological representation make clear and testable predictions about whether and how an individual will participate in a community change over their life. I then test these predictions and find that neither is fully borne out by the data: the individual studied here does not participate in the community change, as usage-based models of phonological representation would seem to predict, but nor is his language completely stable, either: he demonstrates very restricted retrograde change, in only a subset of items. This finding raises a number of questions for future research, including when this kind of change happens, why it happens, to whom it happens, and the implications it has for change at the level of the community.

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2 Background

Language change in later life can be characterized by the nature of the relationship between the individual who changes and the community that serves as their linguistic backdrop (Sankoff 2005; Wagner 2012a). An individual may change their use of a variable which is diachronically stable in the surrounding community ("age-grading," as in Wagner 2012b or Rickford and Price 2013) or one which is involved in community change. Cases in which an individual changes against the backdrop of a changing community can themselves fall into two types: if the individual moves in the same direction as the community – so, increasing their rate of use of the incoming variant as they age – this is "lifespan change" (e.g. Harrington et al. 2000[1]; Raumolin-Brunberg 2005; Sankoff and Blondeau 2007); if the individual moves in the **opposite** direction of the community – increasing their rate of use of an older, declining variant – this is "retrograde change" (Wagner and Sankoff 2011). Additionally attested are cases of later-life change whereby an individual picks up linguistic features characteristic of a community to which they have relocated ("second dialect acquisition," e.g. Nycz 2013). These examples all provide evidence that individuals' language production can change over the course of their lifespans.

Despite the number of case studies of this phenomenon that have accumulated, one point that remains poorly understood is the means by which this intra-speaker change occurs, a point which has important ramifications for theories of phonological representation. In an individual-level analogy to the much-discussed question of how a sound change propagates through the lexicon of a language variety (Labov 2010), we can also investigate the means by which a phonological change progresses within the lexicon of a single speaker, in those cases where an individual shows longitudinal change. Indeed, by restricting our domain of study to a single individual and the lexicon they know, we are working with the most appropriate data to test the validity of theories under which mental representations are directly shaped by an individual's experiences.

A primary example of such a theory is Exemplar Theory (Pierrehumbert 2001), one of a class of usage-based models of grammar (see Hinskens et al. 2014 for a recent review). Exemplar Theory differentiates itself from traditional generative models of phonology (e.g. Chomsky and Halle 1968) by allowing phonetically rich, rather than maximally underspecified, mental representations. A key principle of Exemplar Theory is that these mental representations are constantly updated with memory traces of the language a speaker experiences around them, and that these stored memories feed back into the speaker's language production, with input shaping production over time.

These models have a natural connection to cases in which individuals are surrounded by a community undergoing linguistic change. Because these models treat the grammar as dynamic and sensitive to input, they predict that "lifespan change" – in Sankoff's (2005) technical sense of the term, defined earlier in this section – should, all other things being equal, be common. That is, the mental representations of an individual who is surrounded by a changing community should themselves change concomitantly, hence shaping the individual's production in the direction of the community change.[2]

Exemplar-based models of grammar also predict a role for word frequency in such lifespan change (Harrington 2006), though it's not immediately clear what that role will necessarily be. Nycz (2013) predicts – and, for the most part, finds – that speakers who have moved to a new dialect area pick up features of that new dialect in more frequent words before less frequent words. This is as expected under a model where input drives production: linguistic input by definition contains more tokens of frequent words, thus those lexical items are heard more often, amassing more stored memories with the new-dialect pronunciation than less frequent items, and shaping the speaker's production of them accordingly. At the same time, at least in the domain of morphosyntax, there is a suggestion that "frequency strengthens the memory representations of words or phrases" (Bybee 2006: 715), leading to a situation in which frequent elements actually *resist* change. Either way, under these models of grammar we are led to expect that (a) individuals will be susceptible to change in their linguistic surroundings, and (b) individual-level change will proceed in a manner that shows frequency effects.

The aim of this paper is thus to test these two predictions.

3 Methodology

3.1 The speaker and data

Following related work (Harrington et al. 2000; Sankoff 2004), I sidestep many of the complications inherent to longitudinal research (time, cost, speaker availability) by working with publicly-available longitudinal data. Specifically, I examine the speech of Sir David Attenborough, a well-known nature documentary narrator whose career spans over half a century, beginning in the mid-1950s and continuing to the present day. Attenborough, born in London in 1926 and educated at Cambridge (BBC), speaks with Received Pronunciation (RP), and is

thus a prime candidate for studying individual-level engagement with the generational changes that have affected RP in the twentieth century (Wells 1997). Additionally, the narration in Attenborough's documentaries is of a controlled style (on which more in Section 3.3), allowing us to avoid the confounds of style-shifting and audience design which have complicated other longitudinal linguistic studies (Rickford and Price 2013).

The data presented in this paper come from two time periods, and represent a small subset of the data currently being collected by the author in an ongoing project studying Attenborough's speech at five-year intervals across his entire recording career. The earlier time period studied here comprises data collected from three documentaries aired within a five-year timespan when Attenborough was in his thirties: *Zoo Quest for a Dragon* (Attenborough 1956), *The People of Paradise* (Attenborough 1960), and *Zoo Quest to Madagascar* (Attenborough 1961). All three of these early programs follow a similar structure, juxtaposing segments of onscreen speech, in which Attenborough "breaks the fourth wall" by speaking directly to the audience from a television studio [Video 1], with segments of narration, in which audio is overlaid on prerecorded footage from Attenborough's travels [Video 2]. Many episodes also contain on-location footage of Attenborough speaking with locals, or footage of Attenborough interacting with animals and their handlers in the studio [Video 3].

The later time period comprises data collected from a single documentary series, *Planet Earth* (Fothergill 2006), which aired when Attenborough was eighty. In contrast to the earlier programs, Attenborough never appears in any episode of *Planet Earth*; his speech is entirely voice-over narration [Video 4]. I return to this point in Section 3.3.

Films were accessed through BBC iPlayer and Box of Broadcasts. Audio was extracted using Audio Hijack and transcribed in ELAN, and transcriptions were time-aligned with the speech signal using FAVE-align (Rosenfelder et al. 2011). Attenborough produces 244 min of speech in the three early series combined (ca. 46,000 words), and 242 min in *Planet Earth* (ca. 36,000 words).

3.2 The dependent variable

To test the predictions laid out in Section 2, I examine Attenborough's variable realization of the approximant /ɹ/ as a tap ([ɾ]). In the RP of the early twentieth century, [ɾ] alternated with [ɹ] in certain phonological positions: namely, in word-internal position when intervocalic and following a stressed vowel (e.g. *ve̲ry*, *fo̲rest*), and in hiatus, or "linking" position, between vowels of any stress (e.g. *fa̲r away*, *ou̲r engines*) (Rubach 1996).[3] The tapped variant has also been attested in certain consonant clusters (e.g. *thr̄ee, br̄ight*) for some speakers (Cruttenden 2014; Wells 1982). However, writing in 2012, Hughes et al. indicate that [ɾ] is "rare in contemporary RP," effectively restricted to "very conservative RP spoken by some elderly people" (46–7). Wells (1997) and Cruttenden concur, dating the loss of tapped-r in RP to the early or mid-twentieth century, respectively; Fabricius (2017), analyzing /ɹ/ realization in the BBC sound archives, finds that the [ɾ] variant declines from a rate in the range of 40–50% in the 1950s to approximately 35% word-internally and 10% in linking position by the 1970s. The relevant questions are thus whether Attenborough has participated in this community movement away from the [ɾ] variant over his lifespan, and, if so, whether any such participation shows evidence of frequency effects.

A pilot study of the data revealed little variation in consonant clusters, where Attenborough was found to use [ɹ] almost exclusively. Data for the present study were thus restricted to tokens of /ɹ/ in only the two intervocalic positions (word-internal and linking). In the case of /ɹ/ in linking position, it is worth pointing out that this phenomenon is itself variable: that is, a speaker could produce, in addition to [fɑɹ əweɪ] and [fɑɾ əweɪ], [fɑː ʔəweɪ], with no realization of /ɹ/ at all and a glottal stop to resolve the hiatus instead (Bauer 1984). The latter type of token, in which linking r of any articulation did not surface, was excluded from study. Also excluded from study were tokens of intrusive r, where a non-etymological /ɹ/ is inserted to resolve hiatus (e.g. *claustrophobia-r̄ of*), and tokens of word-initial intervocalic /ɹ/ (e.g. *a r̄eward*). Intrusive r occurred too infrequently in the corpus to merit study; word-initial intervocalic /ɹ/ is said by Rubach (1996) not to be an environment for tapping.

Tokens were identified using a Praat script and coded auditorily by the author with reference to the waveform and spectrogram. Figure 1 shows a sample of the speech stream demonstrating the difference in waveform and spectrogram between [ɾ] (in *very*) and [ɹ] (in *varied*). Tokens were coded as having either a tap [ɾ] or an approximant [ɹ]; occasional trills were coded as taps. Tokens that could not be identified with certainty were omitted.

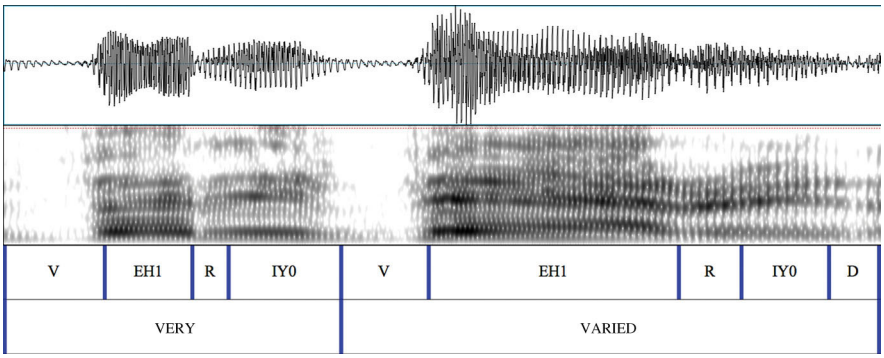

Figure 1: Segment of speech from *Zoo Quest to Madagascar*, episode 1, 0 min 58 s. The word *very* is articulated with [ɾ] and the word *varied*, [ɹ].

3.3 Controlling for style in 1950s-era documentaries

As mentioned in Section 3.1, the series *Zoo Quest to Madagascar*, *Zoo Quest for a Dragon*, and *People of Paradise* depict Attenborough in a variety of speaking contexts. Attenborough comments in his memoir that his onscreen speech in these series was spoken live in the studio, while his voiceover narration was prerecorded and read from a script (Attenborough 2010). Accordingly, we may expect linguistic differences between these settings comparable to those traditionally found between spontaneous and read speech (Labov 1972). To maintain comparability to the later series, *Planet Earth*, in which all of Attenborough's speech is prerecorded narration, any speech from non-prerecorded contexts was omitted from study.

Following the exclusion of speech in non-narration contexts, token counts obtained were as in Table 1.

Table 1: Total number of tokens obtained in narration context, by decade and phonological position.

	internal	linking
1950s	455	307
2000s	615	251

4 Independent variables

Independent variables included in the analysis, in addition to phonological position of the /ɹ/ (word-internal vs. linking position) and decade (1950s vs. 2000s), were time in recording, speaking rate of the seven-word window containing the token (measured in vowels per second), and word/bigram frequency. Frequency counts were taken from SUBTLEX-UK, a 201.7-million word corpus of word counts based on the subtitles of 45,099 British television programs (van Heuven et al. 2014). Van Heuven et al. find that these frequency counts do a better job of predicting lexical decision times for speakers of British English than do counts from other commonly-used corpora, including SUBTLEX-US (based on American television programs).

For tokens of word-internal r, the relevant frequency measure was the frequency of the word containing the /ɹ/ (e.g. *very*). For tokens of linking r, the relevant measure was the frequency of the bigram containing the /ɹ/ (e.g. *far away*). Bigram frequencies are provided by SUBTLEX-UK, but separate frequencies are given for every possible punctuation separator (i.e. separate frequencies are given for *far away*; *far-away*; *far, away*; *far. Away*; and so forth). Only frequencies where the two elements of the bigram were separated by a single space and no other punctuation (e.g. *far away*) were used for analysis.

Both unigram and bigram frequencies were transformed to van Heuven et al.'s Zipf scale by taking the log10 of each item's frequency per billion words. As van Heuven et al. discuss, this provides an intuitive logarithmic scale from 1 (very low frequency) to 7 (very high frequency).

5 Hypotheses

Wagner (2012a), Sankoff (2013) are clear that most adults are linguistically stable in later life. Hence, the primary null hypothesis of this work is that Attenborough will not participate in the community retreat from [ɾ] over time. However, the alternative hypothesis – that Attenborough will show some longitudinal change – is not out of the question. There are three reasons why we might not be surprised if Attenborough is found to change over his lifespan, specifically to retreat from using [ɾ] as the community does.

- Analysis of the data collected from Attenborough's 1950s recordings showed him to use the [ɾ] and [ɹ] variants at roughly equal proportions in his early years (this is reflected in Figure 2, in the upcoming section). This makes him a possible candidate for later-life change: several studies have shown that the individuals who change their production of a variable in later life are those who are not categorical or near-categorical in their use of one or the other variant in their early years, but those who acquired both variants early on and who use them at close to equal rates (Nahkola and Saanilahti 2004; Raumolin-Brunberg 2005; Sankoff and Blondeau 2007).
- The change away from [ɾ] is a rapid one: in Fabricius' real-time study (2017), the rate of [ɾ] in linking position decreases from 40% to 10% in only two decades. Cases of adult participation in community change also frequently involve rapidly-progressing changes; most notably, Sankoff and Blondeau and Raumolin-Brunberg each comment on both the real-time rapidity of the changes they study, and the high rate of individual participation in them displayed by their panel members. (It is very possible that the rapid progression of a change is driven in no small part **by** the continued participation in it of post-adolescent individuals.)
- The [ɾ] variant carries overt social meaning in the community. Wells (1982) describes the "upper-crust" variety of RP to which [ɾ] belongs as often stereotyped, and "conspicuous in a way which makes it impossible to regard [it] as part of mainstream RP" (280). Hughes et al. (2012) similarly describe the "upper-class connotations" of the [ɾ], associating it with the speech of "the frequently lampooned art critic Brian Sewell, who was once described by the British Independent newspaper as 'the poshest man in the world', and by John Humphrys as 'the only man I have ever met who makes the Queen sound common'" (46–7). Conscious awareness of a variant has again been associated with later-life change in previous work (Sankoff 2013; Sankoff and Blondeau 2007; Wagner and Sankoff 2014).[4]

In essence, the social and linguistic profile of the particular change in progress studied here is in keeping with that found in other scenarios where later-life change is attested. Hence, while later-life change is not expected, it would not be out of the ordinary given previous work.

If later-life change **is** found, this allows for a second null hypothesis: that such change will show no effect of frequency. I remain agnostic about the potential direction of any frequency effect predicted by an alternative hypothesis; as discussed in Section 2, usage-based theories allow us to propose that it could go either way (more frequent words lead the change/more frequent words resist the change).

6 Results

Data were subjected to mixed-effects logistic regression using `lme4` v.1.1-12 (Bates et al. 2015) in R v.3.3.2 (R Core Team 2016). Fixed-effect predictors were those identified in Section 4: phonological position, decade, (the log10 of) time in recording, speaking rate, and word/bigram frequency on van Heuven et al.'s Zipf scale. Also included were random effects of episode and item (i.e. the particular word or collocation in which the /ɹ/ occurred). Model output is provided in Appendix A.

Figure 2 shows Attenborough's rate of tap, aggregated across phonological positions, in the two decades under study. There is no significant change in rate of tapping over time ($p = 0.29$).

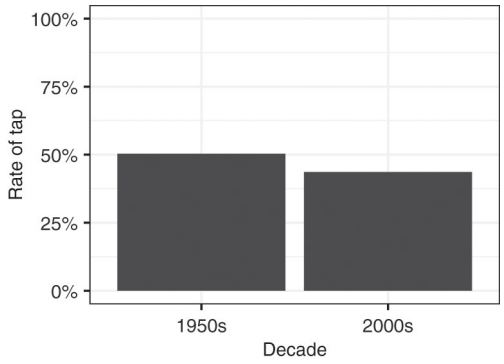

Figure 2: Attenborough's rate of tap over time, both phonological positions combined, in narrative speech.

However, if we separate the data out by phonological position, the picture becomes a little more complicated. Figure 3 shows by-decade tapping rates for word-internal tokens and linking position tokens separately. Based on separate regressions, with the predictors enumerated above, for each phonological position,[5] the apparent decrease in tapping rate in word-internal position does not reach significance ($p = 0.927$), while the apparent **increase** in tapping rate in linking position does ($\beta = 0.724$, $p = 0.018$). In other words, Attenborough appears to be showing retrograde movement – increasing his rate of [ɾ], the conservative variant, over time – though only in linking position.

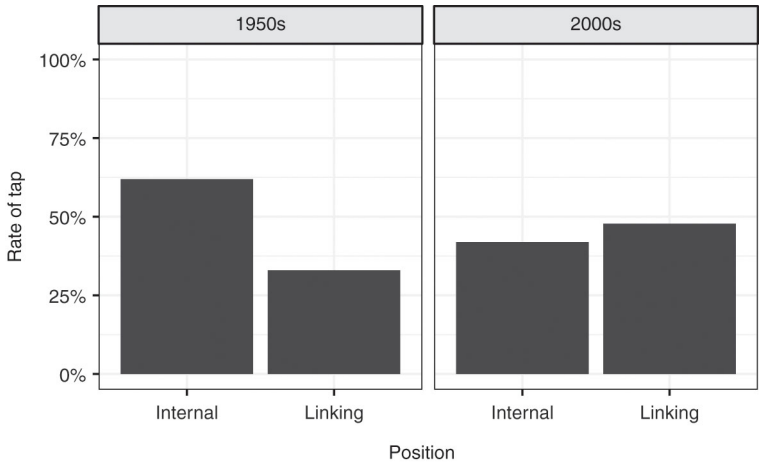

Figure 3: Attenborough's rate of tap over time, by phonological position, in narrative speech.

Another way to think about this effect is to compare the positions within each decade, rather than comparing the decades within each position. A post-hoc analysis of each decade reveals that a significant difference in tapping rate between linking and word-internal position in the 1950s ($\beta = -1.421$, $p = 10^{-6}$) has disappeared in the 2000s ($p = 0.313$). That is, in his early years, Attenborough taps more in word-internal than linking position, but in his later years, he has increased his tapping in linking position such that this distinction has been erased.

When we take the variable of word/bigram frequency into account, the picture becomes even more interesting. Figure 4 splits the data by both phonological position and frequency. To make these graphs, word/bigram frequency was separated into two bins: low (<4 on the Zipf scale) versus high (≥4), following van Heuven et al. (2014: 1179), who say that "the tipping point from low frequency to high frequency [is] between 3 and 4."[6] What we find now is that Attenborough's stable tapping rate in word-internal position is consistent, regardless of frequency: in word-internal position, an interaction term between decade and frequency fails to reach significance ($p = 0.934$). But in linking position, there is a strong effect of frequency: Attenborough significantly increases his rate of tapping in high-frequency collocations, but shows no change to his tapping rate in low-frequency ones. This is borne out by the regression results: in linking position, the `decade*frequency` interaction term is significant at $p = 0.006$ ($\beta = 0.472$). Attenborough thus shows a very restricted retrograde change: he increases his rate of use of [ɾ] only in high-frequency collocations.

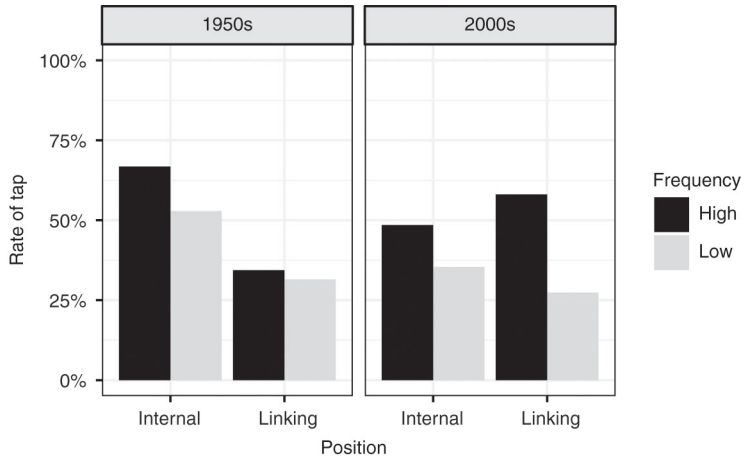

Figure 4: Attenborough's rate of tap over time, by phonological position and binned frequency, in narrative speech.

The two other predictors under study, time in recording and speaking rate, also deserve mention. Time in recording has a significant negative effect on tapping (i.e. less tapping as an episode goes on), in both decades and in both phonological positions (see regression output in Appendix A). This may point to a stylistic effect whereby Attenborough uses formal variants like [ɾ] less often as an episode goes on, a possibility which deserves further investigation in future work. Speaking rate has a significant positive effect on tapping (i.e. more tapping at faster speech rates), though this turns out to hold only word-internally (Appendix A). The lack of an effect of speaking rate on tapping in linking position could be due to the fact that linking r itself, as a variable phenomenon, is more likely to occur at higher rates of speech (Cox et al. 2014); linking tokens may thus not show as wide a range of speaking rates as word-internal ones. Within word-internal position, the finding that faster speech promotes [ɾ] is somewhat surprising, given that fast speech is known to promote reduction, and it is not immediately obvious that [ɾ] is more lenited than [ɹ]. This deserves more investigation.

7 Discussion

There are a number of findings requiring comment here. First is the result that Attenborough does not participate in the community change over time – at least not in the particular style of speech examined here. Despite the loss of [ɾ] in the present-day RP of younger speakers, Attenborough has shown no concomitant change in his narration.

On the face of it, this appears to contradict the prediction of exemplar-based models that individuals' production will be influenced by that of those around them, though this result needs to be taken as tentative until data both from a wider stylistic range and from additional variables can be studied. The best testing ground for the exemplar-based prediction would be a large-scale longitudinal corpus of vernacular speech from a panel of individuals in a community undergoing phonological change, but with a few exceptions (Thibault and Vincent 1990; Vincent et al. 1995; Gregersen 2009), this remains difficult to come by. It nonetheless should remain a desideratum for future work in sociophonetics.

At the same time, we need to account for the finding that Attenborough **does** show (albeit very restricted) longitudinal change. Unexpectedly, this takes the shape of a retrograde movement toward more [ɾ] usage, one which is limited to high-frequency linking-position contexts: collocations like *for a*, *were on*, *their own*, and *here are*. We first need to note that retrograde change across the lifespan has been attested before: Wagner and Sankoff (2011, 2014) find that several members of their panel of Montreal French speakers increased their rate of use of the inflected future – the conservative variant in an ongoing change from inflected to periphrastic future – as they aged. This increase was particularly apparent among speakers of high socioprofessional status, leading Wagner and Sankoff to identify a social motivation for the retrograde movement: they propose that inflected future forms carry associations with formal style, developmental maturity, and social status, and that as speakers reach middle age, their shift toward "the more formal discourse characteristic of [that] life stage" is reflected in an increase in the inflected future (2011: 299).

It seems unlikely that a similar motivation underlies Attenborough's retrograde change, though: there is no evidence that the [ɾ] variant bears its upper-class social connotations only in linking position of high-frequency collocations.[7] Thus, because the [ɾ] variant, as far as we know, is socially evaluated the same way regardless of position, if Attenborough were increasing his rate of use of it for social reasons, we'd expect to see such an increase across the board.

Instead, I propose a different motivation for the observed change in Attenborough's tapping rate: it stems from a change in his mental representation of high-frequency collocations such that they become more word-like over time. Recall that Section 6 showed that, in the 1950s, Attenborough tapped more in internal than in linking position, while by the 2000s, increased tapping in linking position led to this distinction being erased; note also that, as shown earlier, this increase interacts significantly with frequency, such that it is only in high-frequency collocations where the rate of [ɾ] in linking position comes into line with that in word-internal position. It is thus possible that, after having had decades of experience pronouncing high-frequency two-word collocations, Attenborough has come to mentally store them as something more like individual words. His domain-specific retrograde change would thus not reflect any change to the tapping rule, which continues to apply across his lifespan at a steady rate to tokens in word-internal position, and a steady, somewhat lower rate, to tokens in linking position, but instead a change to which instances of /ɹ/ are represented as being in word-internal position in the first place. To return to the typology of later-life changes that we laid out in Section 2, then, we can add another plausible type of language change across the lifespan: change in production stemming from increased experience with one's language over time (see also Guy and Boyd 1990; Raymond et al. 2006).

8 Conclusion

This paper started out testing one particular hypothesis that arises from a usage-based approach to language, and ended up providing potential evidence for a different one. I initially asked whether an individual surrounded by a changing community would reflect the community change in his own language, and, if so, whether this would show an effect of frequency. Usage-based models of phonological representation predict that the answers to both of these questions should be "yes." I then demonstrated that the changing community has not effected a change in the subject's speech, at least not in the speaking style studied here: although Attenborough must be hearing fewer [ɾ]s in the 2000s than he did in the 1950s, his pronunciation in his nature documentaries has not kept pace. Instead, his rate of tapping is stable except in frequently-uttered collocations, and the nature of his longitudinal change is consistent with his having reanalyzed these collocations as words. This finding supports the proposal that frequently-repeated elements of language will become "chunked into units" (Bybee 2015: 38), a proposal which has often been put forth to account for patterns of variation at the community level (e.g. Krug 1998; Scheibman 2000) but which has not, to my knowledge, been demonstrated in the longitudinal behavior of an individual. I wish to conclude this paper by making three points about this interpretation of the data.

First, it should go without saying that the results need to be treated with caution. This study made use of only two time points; as the intervening years are filled in, the picture may change (Rickford and Price 2013). Even more important, the data here are drawn from a single speaker who is not a canonical user of language: speaking is Attenborough's livelihood, and it is fair to criticize the data as reflecting a stylized performance, not his vernacular. This being said, there is no a priori reason why we would expect a stylized performance to lead to the kind of effects seen here, i.e. the boosting of the rate of use of a conservative variant in only a subset of forms. But more data comparing older and younger speakers' production of frequent collocations, even if only in apparent time, will help confirm whether the results proposed here generalize beyond this particular case.

Setting aside concerns about the nature of the data, the second point I wish to address is about the relevance of the results for theories of language change at the community level. The role of frequency in driving sound change is debated (Labov 2010), and it is a long leap from seeing frequency effects at the level of one individual to proposing that these frequency effects drive change in the community. After all, the frequency effect documented in this paper manifests in later life, but elderly speakers are not the ones leading language change: adolescents are (Eckert 1988). There is much scope for future work to carefully flesh out the nature of the connection between frequency effects at the level of the individual and frequency effects at the level of the community.

Finally, this paper serves as a reminder that later-life change is not always socially driven: psychological and even physiological correlates of aging are just as likely to shape speakers' language production (see Tamminga et al. 2016 for a similar point). Future sociolinguistic work connecting language change in later life to cognitive changes across the lifespan will be welcome.

Eckert (1997) describes adulthood as "a vast wasteland in the study of variation" (165). Though this has certainly improved over the past twenty years, I hope to have demonstrated that we still have much to learn about language – its mental representation as well as its surface manifestation – at this stage of life.

Acknowledgement

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Appendix A

The following tables summarize the fixed effects and fit statistics of the models described in Section 6. Accompanying each predictor are coefficient, standard error (in parentheses), and significance level (*p < 0.05; **p < 0.01; ***p < 0.001).

Table A: Both phonological positions combined.

	Dependent variable:
	/r/ = tap
Position = linking	−0.872 (0.232)***
Decade = 2000s	0.282 (0.265)
Frequency (Zipf scale)	0.058 (0.094)
Speaking rate (vowels per sec.)	0.322 (0.051)***
Time in recording [log10(sec.)]	−0.821 (0.211)***
(Intercept)	0.424 (0.725)
Observations	1,627
Log Likelihood	−906.569
Akaike Inf. Crit.	1,829.139
Bayesian Inf. Crit.	1,872.295

Table B: Internal position only.

	Dependent variable:
	/r/ = tap
Decade = 2000s	−0.027 (0.298)
Frequency (Zipf scale)	−0.036 (0.134)
Speaking rate (vowels per sec.)	0.479 (0.068)***
Time in recording [log10(sec.)]	−0.826 (0.267)**
(Intercept)	0.366 (0.924)
Observations	1,070
Log Likelihood	−554.691
Akaike Inf. Crit.	1,123.383
Bayesian Inf. Crit.	1,158.210

Table C: Linking position only.

	Dependent variable:
	/r/ = tap
Decade = 2000s	0.724 (0.307)*
Frequency (Zipf scale)	0.162 (0.117)
Speaking rate (vowels per sec.)	0.050 (0.074)
Time in recording [log10(sec.)]	−0.831 (0.333)*
(Intercept)	0.370 (1.104)

Observations	557
Log Likelihood	−338.327
Akaike Inf. Crit.	690.654
Bayesian Inf. Crit.	720.912

Table D: 1950s only.

	Dependent variable:
	/r/ = tap
Position = linking	−1.421 (0.286)***
Frequency (Zipf scale)	0.099 (0.110)
Speaking rate (vowels per sec.)	0.171 (0.072)*
Time in recording [log10(sec.)]	−0.937 (0.362)**
(Intercept)	1.766 (1.157)
Observations	761
Log Likelihood	−423.174
Akaike Inf. Crit.	860.348
Bayesian Inf. Crit.	892.790

Table E: 2000s only.

	Dependent variable:
	/r/ = tap
Position = linking	−0.377 (0.374)
Frequency (Zipf scale)	0.074 (0.152)
Speaking rate (vowels per sec.)	0.462 (0.079)***
Time in recording [log10(sec.)]	−0.916 (0.284)**
(Intercept)	−0.027 (1.072)
Observations	866
Log Likelihood	−467.664
Akaike Inf. Crit.	949.328
Bayesian Inf. Crit.	982.676

Table F: Internal position only, with decade*frequency interaction.

	Dependent variable:
	/r/ = tap
Decade = 2000s	0.030 (0.764)
Frequency (Zipf scale)	−0.030 (0.158)
Speaking rate (vowels per sec.)	0.479 (0.068)***
Time in recording [log10(sec.)]	−0.827 (0.267)**
Decade*Frequency	−0.014 (0.166)
(Intercept)	0.338 (0.986)
Observations	1,070
Log Likelihood	−554.688
Akaike Inf. Crit.	1,125.376
Bayesian Inf. Crit.	1,165.179

Table G: Linking position only, with decade*frequency interaction.

	Dependent variable:
	/r/ = tap
Decade = 2000s	−1.358 (0.812)
Frequency (Zipf scale)	−0.021 (0.131)
Speaking rate (vowels per sec.)	0.052 (0.073)
Time in recording [log10(sec.)]	−0.831 (0.334)*
Decade*Frequency	0.472 (0.171)**
(Intercept)	1.165 (1.133)
Observations	557
Log Likelihood	−334.419
Akaike Inf. Crit.	684.838
Bayesian Inf. Crit.	719.418

Notes

1 Though see Fabricius 2007, who provides a different interpretation from Harrington et al. of attested vocalic changes in Queen Elizabeth's speech.
2 The magnitude of this effect will necessarily be contingent on a number of factors, including the composition of a speaker's social network: if a speaker never socializes with any linguistically innovative speakers, their opportunity to receive innovative input will be low (Pierrehumbert 2006). Thanks to a reviewer for this point.
3 RP is a non-rhotic variety of English, but word-final post-vocalic /ɹ/ is pronounced before a vowel, e.g. [fɑː] 'far' but [fɑɹ əweɪ] 'far away.' This is generally called "linking r" (Cruttenden 2014).
4 Note, crucially, that Wagner & Sankoff find the social meaning of the variant they study to drive **retrograde** change: as certain individuals in their sample age, those individuals **increase** their rate of use of an old-fashioned, formal variant. We could thus potentially hypothesize that Attenborough would do the same. But because individual retrograde change is still so rare in the literature, I take later-life participation, rather than reversal, to be the more likely alternative hypothesis in Attenborough's case.
5 A single regression on data from both phonological positions with a `position*decade` interaction failed to converge.
6 It is important to note that word/bigram frequency was **not** binned for the regressions referred to throughout the text, only for the graphs, for ease of presentation. For the regressions, frequency was left as a continuous variable.
7 This would be an unexpected situation for any variable, given Labov's observation that the social evaluation of an allophone tends to be consistent across the linguistic contexts in which that allophone surfaces (2001: 28).

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