Regional variation of /r/ in Swiss German dialects

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Abstract

German-speaking Europe is known to feature substantial regional variation in the articulation of /r/. According to historical atlases, this is particularly true for the most southwestern fringe of the region, i.e. German-speaking Switzerland. Large-scale, multilocality studies that show an updated picture of regional variation in this region are lacking, however. To this end, we coded /r/s of almost 3,000 speakers from 438 localities on a predominantly auditory basis, using data crowdsourced through a smartphone app. We report substantial regional variation, with uvular articulations especially dominant in the Northwest and the Northeast and alveolar – particularly tapped – articulations prevalent in the Midlands. We further provide exemplary evidence of an urban ([ʁ]) vs. rural stratification ([ɾ]) in the Northwest. This contribution further discusses (a) issues related to the coding of /r/, given the volatile articulatory and acoustic properties of /r/s and (b) the benefits and pitfalls of the crowdsourcing methodology applied more generally.

Index Terms: rhotics, sociophonetics, regional variation, dialectology, Swiss German

1. Introduction

Rhotic consonants – i.e. /r/-like sounds – are common in the languages of the world: [1] reports that 76% of the 317 languages featured in the UPSID database have one or more r-sounds, most of which are produced at dental/alveolar places of articulation. In European languages, for example, alveolars such as [ɾ] or [r] are widespread in Eastern, Central, Western, and Southern regions, but less prevalent in the North (e.g. Norway, Sweden) [2]. Uvular rhotics (also known as 'gutturals', such as [ʀ], [ʁ], or [χ]) are much less frequent: PHOIBLE [3], which sampled more than 2,155 of the world's languages, reports [ʀ] for only 12 languages and [ʁ] for 65 languages. Uvular rhotics are found, for example, in Dutch, French, Luxembourgish, Polish, and German [4–7]. Within the same language there can be substantial regional variation. In German pre-vocalic positions, for example, [7] reported alveolar, retroflex, and uvular /r/s, as well as voiced uvular and velar fricatives. [8] thus does not exaggerate when claiming that no other phoneme shows as much regional variation as /r/ in German-speaking Europe.

For Alemannic dialects of German, spoken in Switzerland, Germany (parts of Baden-Württemberg and the Swabia district of Bavaria), Austria (Vorarlberg), Liechtenstein, France (Alsace) and Italy (few communities in the Northwest), studies – in particular dialect atlases – have reported substantial allophonic diversity [6, 9–13]. In German-speaking Switzerland alone, the phoneme shows at least five variants: [r, ɾ, ʀ, ʁ, χ]. [12, 14] report /r/-realizations to vary depending on phonological position; word-initially – as in the words *reiten* or *Rad* ('to ride', 'wheel') – they document alveolar variants for most of German-speaking Switzerland, while uvular variants are dominant in the Northeast, around Basel, and in the Northwest in particular. For /r/s following a vowel and preceding a consonant – as in *Gerste* ('barley'), [12, 14] indicate similar geographical distributions, yet many of the Midland localities are reported to have 'weakened' articulations (i.e. tapped rather than trilled alveolars). In more recent studies, [15, 16] report [r] to be typical for Aarau (central Midlands) – with a few instances of [ɾ] or [ɹ], while [ʀ] appears to be in use only idiosyncratically. For the city of Basel, [17] reports [ʀ] to be prevalent and suggests a regional stratification, with the city using [ʀ] and more rural regions preferring [r] or [ɾ]. Since the publication of these historic atlases and the few small-scale studies mentioned, there has been a lack of large-scale, multi-locality analyses on regional variation of rhotics in German-speaking Switzerland.

The present study aims to fill this gap by pursuing three objectives: (1) to assess the current distribution of rhotics in German-speaking Switzerland. To this end, we coded /r/s from nearly 3,000 speakers from 438 localities across German-speaking Switzerland on a primarily auditory basis, using data that was crowdsourced through the smartphone app *Dialäkt Äpp* [18, 19]. *Dialäkt Äpp* allows users to record a set of words that are prompted on the screen (for apps using similar recording functionality see [20, 21]). Given that four phoneticians (all authors) coded /r/s in the data, objective (2) is to assess inter-annotator agreement. This is particularly critical, given the volatile acoustic and articulatory nature of this sound class [22–24]. Finally, we discuss benefits and pitfalls of the applied crowdsourcing methodology more generally (objective (3)). Going into the study, we hypothesize that the geographical patterns emergent from our data corroborate regional distributions that have been previously reported (1). As for (2), we expect substantial inter-annotator variation, as previously reported in [24]. Finally (3), we expect the quality of crowdsourced audio to be sufficient for auditory coding, yet other sampling biases (e.g. oversampling of urban centers) may confound sampling more generally.

2. Methods

2.1 Data collection

The data for the present paper was crowdsourced through *Dialäkt Äpp* (henceforth *The app*) [18, 19]. The app allows users to anonymously record 16 selected words which are known to vary substantially between dialects. The user interface prompts speakers to indicate, i.e. self-declare, their dialect, as well as to indicate their age and gender, before proceeding to the recording instructions. The instructions read 'Please record your voice in as quiet an environment as possible. Keep an approximate distance of about 15 cm between your device and your lips. Please articulate the text loudly and clearly in your own dialectal pronunciation'. Users then recorded the tokens prompted on the screen (see Figure 1, left). Once recordings have been uploaded, they were invited to navigate to an interactive map (Figure 1, center) where they could listen to their own recordings and to those of others (Figure 1, right).

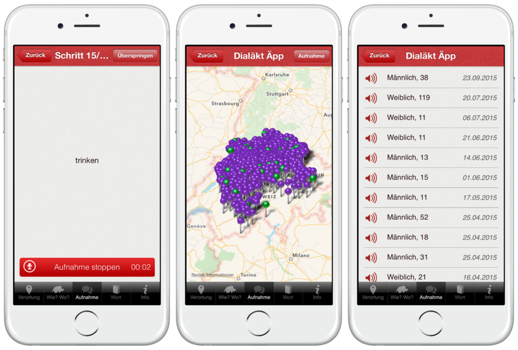

Figure 1: *Interface for word recording (left), localities shown as pins (center), audio playback interface (right).*

The app became the number one downloaded free app for iOS in Switzerland after its release on March 22, 2013 [25]. It received major media attention and has 100,000+ downloads.

2.2 Material

Of the 16 words recorded in the app, only two featured /r/: *trinken* ('to drink') and *fragen* ('to ask). We opted to code the /r/ in *trinken*, given that a preceding plosive might make the rhotic easier to demarcate perceptually than in a fricative-/r/ sequence. Typical articulations of these words are [tʁ̥iŋkə] in Eastern and [ˈtrĩŋkx͡ə] in Western Swiss German dialects. The vast majority of *trinken* recordings demonstrated little background noise; tokens with unfavorable background noise made up 6% (N=171) of the original corpus (N=3,022).

2.3 Localities and speakers

Users who submitted the information described in Section 2.1 served as subjects. They came from 438 localities covering most parts of German-speaking Switzerland. The app crowdsourced recordings from 2851 speakers (discarded tokens accounted for), i.e. 6.5 speakers / locality (mean) or 3 speakers / locality (median). Figure 2 shows the number of speakers for each locality (the data classification for the map is based on Jenks' natural breaks). Each locality is represented by a Thiessen polygon (10 buffer): 'each polygon defines an area of influence around its sample point, so that any location inside the polygon is closer to that point than any of the other sample points' [26]. Layers that demarcate the German-speaking area of Switzerland were retrieved from [27].

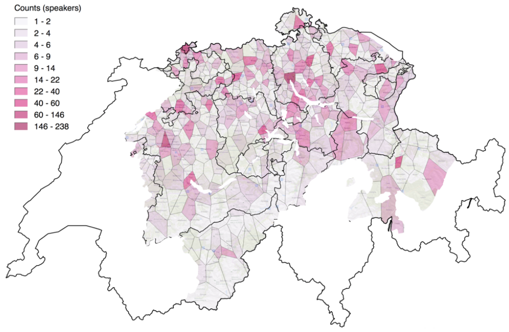

Figure 2: *438 elicited localities in German-speaking Switzerland.*

Urban areas demonstrate the densest net of users. The city of Zurich shows the most speakers by far (N=238), followed by Bern (N=146) and Basel (N=99). Alpine localities have comparatively few respondents. .06% of the German-speaking population (4.9 million in total) is represented in our sample [28]. 50.9% (N=1453) of the participants are males, 49.1% (N=1398) are females. On average, speakers were 31-years-old (median=28). Datasets stemming from speakers aged <5 or >89 were not included; it is possible that these speakers were not felicitous when answering the questionnaire.

2.4 Procedure

Four phonetically-trained annotators (all authors) coded 2851 tokens of *trinken* using the interface depicted in Figure 3. We decided on five categories – four voiced variants, one unvoiced variant; two alveolar variants, three uvular variants – as earlier variationist literature on Swiss German dialects primarily relied on these variants for coding [12, 14].

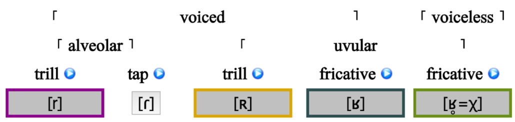

Figure 3: *Annotation interface used in the present study.*

Annotators heard the token and then clicked on the respective button. The interface enabled multiple playback. To assess between-annotator agreement, all authors coded a training set of 100 randomly sampled tokens. Then, each token was coded by two annotators; annotator-pairs varied randomly for every token. We resorted to auditory coding for the vast majority of cases. In some instances, it was prohibitively difficult to identify the exact /r/ allophone based on auditory inspection alone. For these tokens, all authors annotated the /r/s and, where necessary, used spectrographic analysis as an additional criterion [24]. This was the case for 402 tokens. We used the following acoustic cues to determine allophone membership: [r] were identified by repetitive patterns of peaks and troughs in the waveform; [ɾ] by one peak and a trough. [ʀ], too, typically shows a repetitive pattern on the spectrogram. [ʁ] and [χ] were identified by the presence of aperiodic energy, with relatively low frequency spectral peaks [29, 30].

2.5 Data analysis

Data were analyzed using R [31] using binomial GLMs. All factors (*age*, *gender*, *city*) were input as fixed factors *(glm(feature ~ city + age + gender, data=data, family= "binomial")*. We used QGIS [32] for spatial visualization. To account for speaker-idiosyncratic or geographical outliers, we applied a nearest neighbor normalization on the dataset. In this normalization procedure, the most frequent answer per locality of the ten geographically nearest localities is shown for the locality in question [33], illustrated in Figure 4.

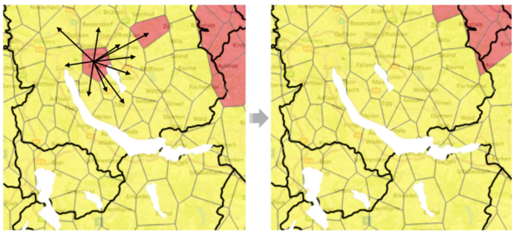

Figure 4: *Illustration of nearest neighbor interpolation.*

In Figure 4, the locality in question is Fällanden. Without normalization, Fällanden features [ʀ] (red) but is surrounded by [ɾ] (yellow), left panel Figure 4. It is likely that this is an idiosyncratic or geographical anomaly. If we then apply the normalization, which selects the ten geographically nearest localities (indicated with arrows on the left in Figure 4) and shows the most dominant answer of these localities for Fällanden, this will render Fällanden as featuring [ɾ] (yellow) as well (right panel, Figure 4).

3. Results

3.1 Coding reliability

Results on the training set of 100 randomly sampled tokens revealed an agreement of 74% for four annotators, i.e., 74 tokens were labelled identically by all four annotators (Fleiss' Kappa=.67, indicating *substantial agreement* [34]). The majority of these 74 tokens were alveolar taps (89%); the remaining 11% were uvular fricatives. Annotators disagreed on every fourth token (26%, i.e., 26 tokens) for reasons of idiosyncratic preferences: two coders, for instance, had a bias towards voiced uvular fricatives, another towards voiced uvular trills. The fourth coder was balanced between uvular fricatives and uvular trills – which illustrates fine perceptual differences between the categories. When coding the entire corpus (2851 tokens), annotator pairs disagreed on 402 tokens (i.e. 13% of the entire corpus). All four annotators then coded these 402 tokens with the help of acoustic analyses where necessary. Results revealed an inter-annotator agreement of 54% (Fleiss' Kappa=.58, indicating *moderate agreement*). This subset was made-up of 24% alveolar and 76% uvular articulations while the training set contained 72% alveolar and 28% uvular articulations.

3.2 Supralocal variation

Figure 5 shows the raw (i.e. geographically non-normalized), regional distributions of /r/. Each Voronoi polygon represents one of the 438 localities. The mode response, i.e. the most frequent answer, is shown for each locality.

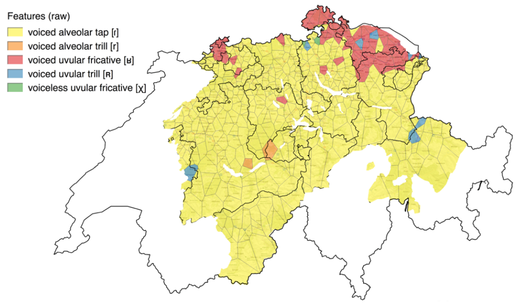

Figure 5: *Regional distribution of /r/ across German-speaking Switzerland (raw).*

Figure 5 reveals that the vast majority of German-speaking localities feature [ɾ] (yellow) – with some islands of [ʀ] (blue) in the West and the Southeast, of [r] (orange) in the Bernese Oberland and Obwalden, and [ʁ] (red) in the Midlands. There are hotspots of [ʁ] in the Northeast and the Northwest. After applying a ten nearest neighbor normalization (cf. 2.5, Figure 4), we obtain the following distribution, which roughly divides German-speaking Switzerland into alveolar [ɾ] (yellow) and uvular [ʁ] (red) articulations, see Figure 6.

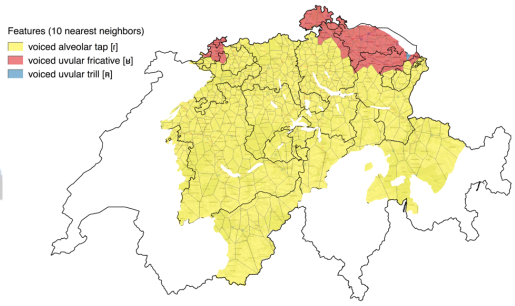

Figure 6: *Regional distribution of /r/ across German-speaking Switzerland (geographically-normalized).*

The islands described earlier have been normalized and an obvious uvular Northwest and Northeast versus alveolar rest becomes evident. Results from the binomial GLM did not show an effect of *age* or *gender* – i.e. the patterns obtained exist regardless of the speakers' age or gender.

3.3 Local variation

The literature review suggested potential stratification of urban versus rural regions, particularly so for the region of Basel [17]. To this end, we performed more localized analyses and examined distributions of /r/ in Basel (urban, N=99) and Pratteln (suburban, in the proximity of Basel, N=15). The two cities are 12 km apart (20-minute car drive). For simplicity's sake, we pooled all alveolar articulations, i.e. [r, ɾ] and all uvular articulations [ʀ, ʁ, χ] to arrive at binary categories: alveolar and uvular. Figure 7 shows the geographical location of Basel and Pratteln (left) as well as the distributions of alveolar vs. uvular articulations by locality (right) in absolute numbers.

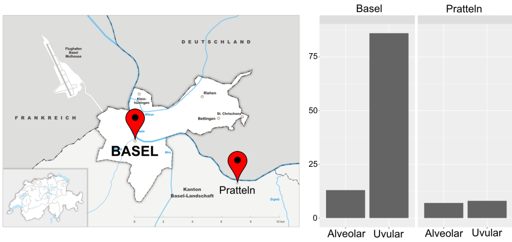

Figure 7: *Location of Basel and Pratteln (left) and distributions of /r/ articulations by locality (right).*

Figure 7 reveals an obvious preference for uvular articulations in Basel (87% of all /r/s), compared to much more evenly distributed fronted and backed articulations of /r/ in Pratteln (54% of all /r/ are uvulars).

4. Discussion

The present study aimed to address the following research questions: (1) to assess the current distribution of rhotics across German-speaking Switzerland, (2) to evaluate inter-annotator agreement for the coding of /r/, and (3) to discuss the benefits and pitfalls of the crowdsourcing methodology applied more generally.

4.1 Regional variation

The findings of the current study largely corroborate previously documented distributions of /r/ in German-speaking Switzerland [12, 14]: there is a divide between alveolar and uvular articulations of /r/, the latter occurring predominantly in the Northeast and the Northwest. One may infer from this that the geographical distributions have remained relatively unchanged over the past 70 years. However, the comparison to historical data is a major source of uncertainty: (i) the geographical distributions in [12] are for word-initial <r> as in *reiten* or *Rad* ('to ride', 'wheel'). We coded /r/s following a plosive in word-initial position – which, perhaps, may favor alveolar articulations given the preceding alveolar /t/. (ii) [12] used a phonetic transcription system based on Böhmer and Ascoli [35], which roughly reflects *Teuthonista* phonetic transcription conventions that were prevalent among German dialectologists at the time. Direct comparisons between our IPA coding does not straightforwardly translate to *Teuthonista* – and vice versa. Finally, our analyses on the local level for Basel and Pratteln broadly support the findings reported by [17] in this area, with [ʀ] being dominant in the city of Basel and [r] being more prominent in surrounding areas. A natural progression of this work will be to analyze further neighboring rural towns and villages to validate this claim.

4.2 Coding reliability

Results from the training set, where all authors annotated 100 tokens, revealed substantial agreement between annotators. We further found that two annotators were in agreement for 87% of tokens for the entire corpus – the tokens disagreed on (13%, N=402) were uvular articulations in particular. Qualitative and impressionistic observations revealed that it was often unclear whether the uvula (active articulator) was flapping against the back of the tongue (passive articulator) – in which case we would have labeled [ʀ] – or whether the two articulators were close enough to cause turbulence, i.e. [ʁ, χ]. Inspection of the waveform and the spectrogram were not always conclusive – in some instances the /r/ was perceived as though there was a repetitive hitting pattern, i.e. [ʀ], yet the spectrogram or the waveform did not show evidence of this. Likewise, there may have been a repetitive uvular peak-trough pattern in the spectrogram or the waveform, but perceptually, it sounded more like friction noise. Further, we would have liked to include tapped [ʀ̆], as this appears to be another – relatively common – allophone of /r/ in Swiss German. Our findings thus suggest that uvular variants of /r/ in particular call for multiple coders [24].

4.3 Benefits and pitfalls of crowdsourcing methodology

A (big) note of caution is due since crowdsourced data has been known to be noisy (literally and metaphorically): 6% of the original tokens (N=171) had to be discarded due to background noise in the signal. Further, the data contains a substantial bias towards urban centers, with major cities being oversampled and rural regions, particularly alpine ones, being undersampled (see Figure 2). This renders claims about distributions of rural regions much less precise. For example: the map displaying the raw, geographically-non-normalized data (cf. Figure 5) indicates outliers – such as [ʀ] (red) in the Midlands surrounded by [ɾ] (yellow). This 'outlier' is due to the fact that we only sampled one speaker from the village of Neudorf, who happened to use [ʀ] (red) in *trinken* – compared to a neighboring Sursee for which we sampled 13 speakers and where [ɾ] (yellow) is clearly dominant. Our sample further is young (median age = 28) and probably highly educated (see [36]) – and thus not representative of the German-speaking population as a whole. Another major issue is that we ask speakers to self-declare their dialect (cf. section 2.1). [37] has shown that lay speakers can have poor intuitions when it comes to assessing their non-standard language use. That is, can we trust the speakers' self-declaration of their dialectal origins? Furthermore, speakers may have recorded themselves multiple times [38, 39]. These factors contribute to noise accumulation, which leaves us with the problem of having to cut through the data to find insightful results.

Crowdsourced data still bears countless advantages: it has the potential to provide evidence of regional distributions that would be prohibitively difficult to achieve with traditional methods – given the potential costs involved. Most importantly, the spatial resolution of 438 localities is unprecedented since the time of [12], and more recent studies rely on a much-reduced net of localities [15–17]. Finally, contemporary smartphones feature frequency responses that enable high-quality audio recordings [40]; even a first-generation iPhone (2007) can collect audio data that enables reliable acoustic measurements [41] – ideal for a study of rhotics. We are convinced that smartphone technology, in particular smartphone recording capability, will be harnessed more extensively in research on sociophonetics and dialectology in the future.

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