PRODUCING AND PERCEIVING SOCIALLY INDEXED COARTICULATION IN AFRIKAANS

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ABSTRACT

This study reports on socially structured variation in anticipatory nasal coarticulation in two socio-ethnic varieties of Afrikaans. Nasal airflow measures show that White Afrikaans speakers produce more extensive vowel nasalization than Kleurling Afrikaans speakers. In perception, these same participants were predicted to use their experiences with these varieties in judging Kleurling and White speakers' oral (CVC) and nasal (CVN(C)) stimuli in an eye-tracking task. Evidence of prior perceptual expectations did not emerge. However, listeners did show clear evidence of perceptual adaptation to and use of the coarticulatory information: over the course of the task, they relied increasingly on the earlier disambiguating nasalization in White (relative to Kleurling) Afrikaans in their perceptual decisions. Moreover, adaptation patterns were partially specific to the listeners' native variety, indicating that listeners' perceptual strategies are complexly conditioned by the social structure of produced coarticulatory variation in the Afrikaans speech community.

Keywords: Afrikaans, coarticulatory nasalization, production, perception

1. INTRODUCTION

Speakers of different languages and different varieties of the same language differ in the extent and timing of anticipatory nasalization of vowels preceding nasal consonants [7, 9, 20]. Because this coarticulation is lawful and predictable, listeners rely on its acoustic manifestation to differentiate words with and without nasals. English-speaking listeners, for instance, can distinguish CVC and CVNC words (*bet–bent*) based solely on differences between the vowels (oral vs. nasalized) [1]. However, the extent to which a listener relies on coarticulatory nasalization depends on several factors, including the nasalization patterns in the listener's native language [3] and the extent to which an individual uses nasalization in their own productions [2].

A question that naturally arises is whether listeners make differential use of nasalization based on the coarticulatory patterns in the speech of their interlocutor. Specifically, do listeners adjust their perceptual strategies to rely more on nasalization for speakers who produce extensive nasal coarticulation, and less for speakers who produce less nasalization? Listeners are known to change their perceptual strategies based on the actual or presumed identity of a speaker. Hay and Drager [10], for instance, showed that listeners change how they identify vowels based on whether they assume the speaker to be from Australia or New Zealand. Such adjustments are not automatic, however, and depend on factors such as the listener's experience with the patterns associated with the different language varieties [13], and potentially also with the differences in prestige associated with different varieties [12]. Under certain conditions, even after only limited exposure, listeners can also rapidly adjust their perceptual strategies to the properties of a specific speech variety with which they may not have been previously familiar [8, 14].

In this study, we investigate language users' differential use of coarticulatory information by exploring coarticulatory nasalization in the production and perception of two socio-ethnic varieties of Afrikaans that have been claimed to differ in the extent of coarticulatory nasalization: "Kleurling Afrikaans" and "White Afrikaans".[1] Impressionistic phonetic descriptions of Afrikaans have described White Afrikaans as having extensive nasalization, and Kleurling Afrikaans as having limited or even no nasalization [4, 5, 6, 15]. We first confirm that speakers of these two varieties differ as claimed in their production of coarticulatory nasalization, and then investigate whether, as listeners, these same individuals make differential use of coarticulatory nasalization based on whether they are listening to a speaker of White or Kleurling Afrikaans. Although recent work shows that how closely a listener attends to coarticulatory information is linked to that individual's own production patterns [2], we nonetheless expect that Afrikaans listeners will adjust their reliance on nasal coarticulation based on a speaker's socio-ethnic variety. In this case, listeners should rely more on nasalization when presented with

(heavily nasalized) White Afrikaans speech and less when presented with Kleurling Afrikaans speech.

2. PRODUCTION OF COARTICULATION

2.1. Methods

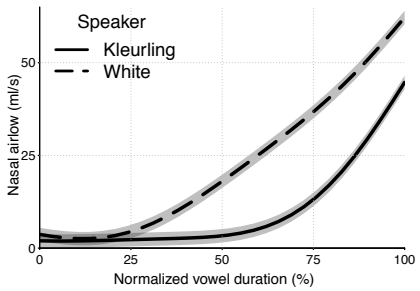
Speakers produced 10 randomized repetitions of 10 CVC words (e.g., /pɔs/ *pos* 'mail') and 10 CVN(C) words (e.g., /pɔns/ *pons* 'punch', /kɑn/ *kan* 'can'). Each word was elicited from speakers via simultaneous presentation of a drawing representing the word and its orthography.

Participants were 42 speakers of Kleurling and 43 of White Afrikaans who were students at the North-West University, Potchefstroom, South Africa. Speakers read the stimuli in the frame sentence *X is die woord* 'X is the word' while holding a soft split oral-nasal silicone mask tightly against their faces to capture separate oral and nasal airflow using the Glottal Enterprises Oral-Nasal Airflow system. Nasal airflow was extracted from the vowel portion of CVN(C) words.

2.2. Results

Based on the literature reviewed above, we hypothesize that nasal airflow should both begin earlier and potentially have a larger volume in White than in Kleurling Afrikaans, indicative of more extensive nasalisation in the former variety. Statistical analyses were conducted by submitting nasal airflow measures from CVN(C) words to a Generalized Additive Mixed Model (GAMM) [17] using the *mgcv* [19] and *itsadug* [16] packages in *R* [11]. GAMMs fit data with a sum of smoothing spline functions (i.e., *smooths*) [18]. Nasal Airflow was entered as the dependent variable in the model. Fixed factors included Participant Ethnicity (White/Kleurling), Normalized Vowel Duration (smooth) and their interaction, while Participant-wise slopes for Word were entered as a random effect. All terms reached significance.

Figure 1: Model-derived nasal airflow during duration-normalized vowels of CVN(C) words for speakers of White and Kleurling Afrikaans (random effects excluded)



Model-derived airflow patterns are shown in Figure 1 (random effects excluded) with shading around the lines marking 95% confidence intervals. Inspection of this figure shows that nasal airflow starts earlier for speakers of White (around 20% into the vowel) than Kleurling (slightly over 50% into the vowel) Afrikaans, and also that the overall volume of nasal airflow is higher for White than for Kleurling Afrikaans. These findings confirm earlier impressionistic descriptions of Afrikaans that have claimed more extensive anticipatory nasalization for White than Kleurling Afrikaans.

3. PERCEPTION OF COARTICULATION

3.1. Methods

The perception experiment monitored the same participants' eye movements during audio-visual trials using an EyeLink 1000 Plus (SR Research) remote eye-tracker. Target stimuli were 10 minimal CVC–CVN(C) pairs (e.g., /pɔs/ *pos* 'mail' – /pɔns/ *pons* 'punch'). The auditory stimuli were produced by two female speakers, one of Kleurling and one of White Afrikaans. To control for the time course of the unfolding information in these eye-tracking trials, original stimuli were cross-spliced so that, for each oral-nasal pair, initial portions of both words (up to onset of vowel nasalization) were acoustically identical (e.g., [p] and the oral portion of [ɔ] in *pos* and *pons* were from the same *pos* token). Splicing also ensured that the vowels of the Kleurling and White Afrikaans speakers' nasal stimuli were nasalized for roughly the final 25% and 80% of the vowel, respectively. So that similar methods were applied to all stimuli, final portions of oral words were also cross-spliced from another token of that word. Filler stimuli were 10 minimal pairs differing in oral codas (e.g., /tɑs/ *tas* 'bag' – /tɑk/ *tak* 'branch'). Each trial consisted of one auditory and two visual stimuli. Visual stimuli were black and white line drawings (also used in the production study) corresponding to each of the 40 words.

Because the speakers who produced the stimuli also provided trial instructions (e.g., *Kyk na die sketse* 'Look at the images'), and because Kleurling and White Afrikaans differ in multiple phonetic properties, listeners could readily determine the Afrikaans variety spoken by each speaker prior to hearing the target stimuli. Our goals are to determine whether listeners (i) use the available coarticulatory information and (ii) have expectations about the coarticulatory patterns of these two Afrikaans varieties. To address (ii), stimulus presentation was blocked into an "oral" block consisting of oral CVC and filler stimuli followed by a "mixed" block

consisting of all stimuli (oral, nasal, filler). Listeners heard multiple randomized repetitions of all stimuli, with half of the repetitions of the oral stimuli occurring in the oral block. All listeners completed a perception task based on the stimuli produced by both the White and Kleurling Afrikaans speakers, presented on separate days in an order counterbalanced across participants.

3.2. Perceptual hypotheses

H1: We expect listeners to rely on coarticulatory information during perception [1, 2], and therefore hypothesize that all listeners will look earlier at the nasal image when hearing a CVN(C) word produced by the speaker of White than Kleurling Afrikaans (since vowel nasalization begins earlier in the White than the Kleurling Afrikaans stimuli).

H2: We also hypothesize that listeners' prior experiences with these coarticulatory patterns may lead them to *expect* earlier onset of nasalization in the White than the Kleurling Afrikaans CVN(C) stimuli [10]. This expectation could influence fixations on CVC words, where vowel orality unambiguously indicates a CVC target (and eliminates a CVN(C) competitor) for the White but not Kleurling variety. Thus, in the oral block, prior to hearing any CVN(C) words, listeners may fixate on the oral target earlier in response to a CVC word produced by the White than by the Kleurling speaker.

H3: Our final hypothesis is that listeners will rapidly adapt to each speaker's timing patterns and adjust their perceptual strategies accordingly [8, 14]. Beyond any variety-based expectations they may bring to the task, these listeners are also hearing speaker-specific coarticulation: the initial ambiguity for a given CVC-CVN(C) pair is resolved about 20% into the vowel for the White speaker's words but not until 75% for the Kleurling speaker's. Because this speaker-specific coarticulatory information only becomes available during the mixed (oral + nasal) block, learning should emerge in oral-to-mixed block *change* in listeners' responses to CVC targets. We predict that, relative to the oral block, in the mixed block fixations for the Kleurling speaker's CVCs should be delayed and/or fixations for the White speaker's should be faster.

3.3. Results

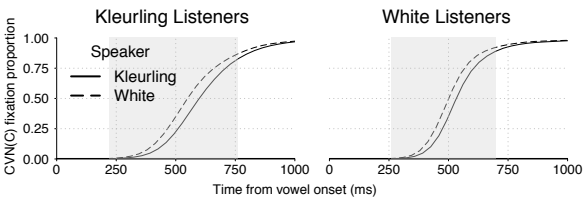
Statistical analyses were conducted by submitting eye gaze data to GAMMs with a logit link function. The structure of the model used is given in Table 1, (K = Kleurling and W = White).

H1 (that listeners rely on nasal coarticulation) is assessed by comparing the model-derived target fixations in response to nasal CVN(C) words produced by each of the White and Kleurling speaker, separately for the White and Kleurling listeners. Figure 2 shows the model-derived target fixations for Kleurling and White listeners; shaded portions indicate where significant differences were found in the odds ratio of fixations on the target image for the White vs. Kleurling speaker. As predicted, both White and Kleurling listeners are faster to fixate the nasal target for the White than Kleurling speaker, indicating that both listener groups rely on the earlier disambiguating nasalization in White Afrikaans.

Table 1: List of fixed and random effects in model

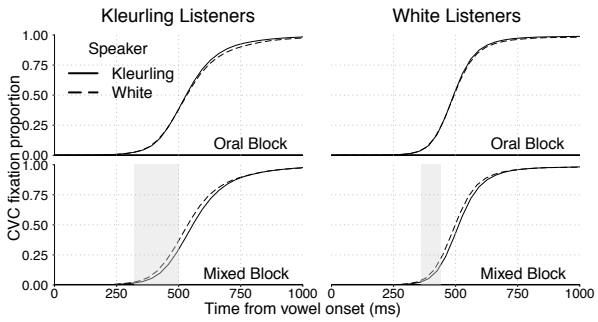
Fixed Factors	Speaker Ethnicity (K/W), Participant Ethnicity (K/W), Target Nasality (Nasal/Oral), Block (Oral/Mixed), Speaker x Participant Ethnicity, Speaker x Target Nasality, Speaker x Block, Participant Ethnicity x Target Nasality, Participant Ethnicity x Block
Fixed Smooths	Time, Time x Speaker, Time x Participant Ethnicity, Time x Target Nasality
Random Smooths	Participant by Target Word

Figure 2: Model-derived target fixations to nasal (CVN(C)) targets by Kleurling and White listeners according to speaker (random effects excluded)



We assess H2 and H3 (concerning perceptual expectations and adaptation) by comparing model-derived fixations on oral (CVC) targets produced by the Kleurling and White Afrikaans speakers in oral and mixed blocks. The top panels of Figure 3 show that H2 (the "expectation" hypothesis) is not upheld. In the oral block, prior to hearing any CVN(C) words, neither Kleurling nor White listeners have earlier fixations on CVC targets when hearing the White speaker's utterances than the Kleurling speaker's. Thus, either listeners' knowledge of coarticulatory nasality (and orality) in these varieties did not facilitate perception prior to exposure to these speakers' nasal productions or listeners lacked such knowledge about the different varieties.

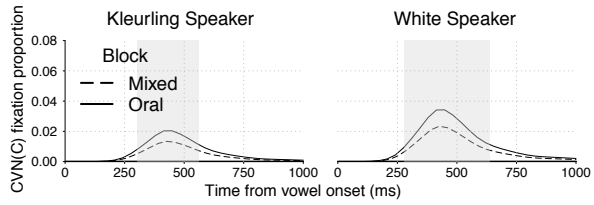
Figure 3: Model-derived target fixations to oral (CVC) targets by Kleurling and White listeners according to speaker and block (random effects excluded)



However, as predicted by H3, listeners did *adapt* to the coarticulatory patterns: in the mixed block (Figure 3 bottom panels) listeners fixated on the target image earlier when hearing the White than the Kleurling speaker's CVC stimuli.

Figure 3 (bottom) also shows that the temporal domain of significant target fixation differences to the White vs. Kleurling stimuli (shaded region) is more extensive for the Kleurling than the White listeners. That perceptual adaptation is more robust for the Kleurling listeners emerges as well in these listeners' fixations on competitor (CVN(C)) images. Figure 4 shows that, when responding to CVC stimuli, Kleurling Afrikaans listeners were less likely to incorrectly fixate on the CVN(C) images in the mixed than in the oral block that preceded it—that is, they were less likely to interpret an oral vowel as consistent with CVN(C) once they had gained information about coarticulatory nasalization for the Kleurling (left) and White (right) speakers. In comparison, for the White listeners (not shown here), nasal competitor looks were not significantly different for the oral vs. mixed blocks for either the Kleurling or White speaker.

Figure 4: Model-derived nasal competitor fixations for auditory oral targets by Kleurling listeners according to speaker and block (random effects excluded)



4. DISCUSSION

In this paper, we presented confirmation of earlier claims, based on impressionistic observation, that coarticulatory nasalization is more extensive in White than Kleurling Afrikaans (Figure 1). With regard to the perceptual use of coarticulatory nasalization, we showed that both Kleurling and White listeners rely perceptually on this information (H1), as evidenced by earlier looks to a nasal CVN(C) target for the White than for the Kleurling speaker (Figure 2).

We also found evidence for adaptation of perceptual strategies (or perceptual learning) by both Kleurling and White listeners (H3). Although neither listener group showed different fixation patterns for the different speakers in the oral block, both groups looked earlier in the mixed block in response to the oral CVC produced by the White than the Kleurling speaker (Figure 3). This adaptation was more robust for Kleurling than for White listeners—a difference that is further supported by the finding that, when presented with an oral CVC auditory target, Kleurling (but not White) listeners were less likely to incorrectly fixate on nasal CVN(C) images in the mixed than the oral block (Figure 4). Given that White Afrikaans is the "standard"/prestige variety of the language, speakers of Kleurling Afrikaans have more exposure to both varieties than speakers of White Afrikaans. The more robust adaptation for Kleurling listeners may hence indicate that these listeners are generally more attuned to variation in coarticulatory nasalization than White listeners.

Counter to H2, we did not find evidence that listeners brought to the task variety-specific expectations about patterns of coarticulatory nasalization. The absence of earlier looks to the CVC target images for the White than the Kleurling speaker's stimuli in the oral block (Figure 3) could mean that absence of velum lowering is less informative than its presence [1]. Alternatively, it may be that listeners lack knowledge of the coarticulatory timing patterns in White and Kleurling Afrikaans. Also possible is that, in this task, listeners relied less on variety-general patterns and more on individual speaker differences (hence the adaptation from the oral to the mixed blocks). Had we used several speakers of each variety, listeners may have generalized to the patterns typical of each variety, and we may have been able to find evidence for expectation-based differential reliance on variety-specific coarticulatory information.

This research shows that the perceptual strategies of listeners can be conditioned in complex ways by the social structure of produced variation in a speech community. One of the broader goals of our research program is to understand how production and perception patterns in individual speaker-listeners are related. These results show that, to understand this relation at the individual level, it is necessary to take into account the social context in which the speech is embedded.

5. ACKNOWLEDGEMENTS

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[1] We acknowledge the problematic nature of the terms "White Afrikaans" and "Kleurling Afrikaans." The socio-ethnic groupings indicated by "White" and "Kleurling" are problematic constructs that oversimplify the lived realities of Afrikaans-speaking individuals. For example, not all participants in this study self-associated with one of these two terms. In the post-experiment survey in which they indicated their affiliation with different sub-groups of the Afrikaans speech community, participants considered to be speakers of Kleurling Afrikaans for the purposes of this study typically self-identified as "Kleurling", "Coloured" or "Brown", while those considered here to be speakers of White Afrikaans all self-identified as "White". Similarly, not everyone who may self-identify as belonging to one of these two socio-ethic groups necessarily speaks the variety of Afrikaans traditionally associated with that particular group. The terms are used here as convenient labels only to refer to two parts of what is likely a dialect/style continuum, rather than two distinct varieties of the language.