SPIRANTIZATION OF WORD-FINAL PLOSIVES IN STANDARD DUTCH

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ABSTRACT

Lenition is a cover term for a set of processes involving reduction or weakening of segments in similar phonological positions [1]. Many studies of plosive lenition have quantified the reduction in terms of consonant duration and intensity. However, this may not give a full picture in cases of "loss lenition," which generally occur in perceptually weak positions [2], such as word-finally. This study reports patterns of word-final spirantization in Standard Dutch from a corpus of word lists. We quantify lenition by duration and the presence/absence and timing relations of acoustic cues, including a complete closure, a transient burst, and a period of frication. Additionally, we investigate sociolinguistic factors that condition this variable lenition and find spirantization significantly more often in male speakers versus female speakers, and in younger versus older speakers.

Keywords: spirantization, Dutch, obstruents, sociophonetics

1. INTRODUCTION

Plosive lenition is realized in many forms, including (but not limited to) weakening to a fricative or approximant ("spirantization"), affrication, flapping, debuccalization, and deletion [3, 4]. Katz [2] describes two subsets that are phonetically and phonologically different: CONTINUITY LENITION and LOSS LENITION. CONTINUITY LENITION refers to intervocalic consonant lenition that results in shorter durations and/or higher intensities, which has been frequently reported in the literature [1, 5, 6, 7]. On the other hand, LOSS LENITION refers to perceptually weak positions undergoing a loss of features, gestures, and/or a contrast, such as coda consonant debuccalization in Andalusian Spanish [8, 9]. Phonological position is frequently described as a predicting factor of lenition, as well as stress [7], the openness of the preceding vowel [10], and speech rate [1]. Lenition can also be socially conditioned; for example, a sociophonetic study of stop lenition in Concepción, Chile, revealed that variable lenition is a social phenomenon, primarily driven by younger male speakers [5]. In the present study, we examine a case of variable (loss) lenition of word-final plosives in Standard Dutch.

1.1. Dutch word-final plosives

Dutch contrasts five plosives: /p, b, t, d, k/, with /g/ as a marginal phoneme seen in loanwords [11]. Historically, Dutch contrasted voicing in all phonological positions, but eventually underwent word-final neutralization. However, this neutralization has been found to be "incomplete," as small but statistically significant differences remain in cues to underlying voicing, such as closure and burst durations, and the preceding vowel duration [12, 13, 14, 15]. Furthermore, native speakers can use these cues in word recognition to make lexical distinctions at a rate better than chance [12, 13, 15], such as with underlying minimal pairs /vɛt/ 'law' and /vɛd/ 'bet.' However, a recent study of word-final voicing cues suggests that the incomplete neutralization is heading towards completion, as the burst duration cue has completely neutralized, and the closure duration cue was only significant in perception, but not production [15].

Mitterer and Ernestus [16] have reported that word-final /t/ can be variably lenited, especially in consonant clusters. In a corpus study of casual speech utterances, they identified four realization patterns of word-final /t/. The first type was a canonical plosive, with a closure, transient, and frication noise. The second type lacked a closure and transient, but had frication. Similarly, the third type had only frication, though at a lower amplitude and with a lower spectral center of gravity. The final realization was a complete deletion. Their analysis then focused on fully deleted tokens, leaving the other realizations of lenition unstudied.

Word-final /t/ is the only segment previously discussed in the literature, but it is not the only plosive to lenite in Standard Dutch. The present study adds to previous work by analyzing word-final lenition in /t, d, k/, giving a more robust view of this phenomenon. (Word-final /p, b/ is extremely rare in Dutch, and thus often left out of word-final stop analyses [15]. For this same reason, we do not

analyze word-final /p, b/.) If lenition is found to occur in /t/ but not /d/, then perhaps the incomplete neutralization described above is changing into a new contrast, where /t/ surfaces as [t̺], and /d/ surfaces as [t]. Furthermore, we examine lenition in careful speech, where it is less likely to occur [10]. We give a qualitative and quantitative description of the types of plosive realizations, and then examine possible sociophonetic conditioning factors of this lenition process.

2. METHODS

2.1. Data

Our data come from a corpus of word lists and read speech from 25 native speakers of Standard Dutch, all living in Amsterdam at the time of recording. The speakers formed two age groups: a younger group (n=14, ages 22-29) and an older group (n=11, ages 61-71). Both age groups were balanced for gender. The corpus was originally compiled to study cues to plosive voicing neutralization in word-initial and word-final position, so it includes many tokens of (underlying) minimal pairs. See [15] for more details on the speakers and corpus.

2.2. Analysis

Only word list productions are considered in this study. Audio files were force-aligned using the Montreal Forced Aligner [17] and segment boundaries were hand-corrected in Praat [18]. A total of 1,287 word-final tokens were further assessed for the presence or absence of a closure, transient burst, and frication period. We qualitatively assigned tokens to categories based on these cues and their temporal relations to each other. TYPE 1 was a canonical plosive with a complete closure, transient burst, and frication period. TYPE 2 had a complete closure and a frication period, but no visible or audible burst. TYPE 3 had unclear divisions between subsegments, exhibiting some type of (partial) closure but overlapping frication and transient burst. Finally, TYPE 4 was completely fricated.

Possible social and linguistic conditioning factors of lenition were then analyzed with an ordinal logistic regression model using the polr function of the MASS package [19] in R [20] to predict lenition type. The social factors that were included were gender (levels: female, male) and age group (levels: younger, older). The linguistic variables included plosive (levels = t, d, k), plosive duration, preceding vowel frontness (levels = front, back), and preceding

vowel openness (levels = open, mid, near-close, close).

3. RESULTS

3.1. Realizations

A majority of plosives (80%) had canonical realizations, which we will refer to as TYPE 1. An example is shown in Figure 1. Their closures averaged 94 ms, and the post-burst frication periods averaged 178 ms. The average total plosive duration was 272 ms.
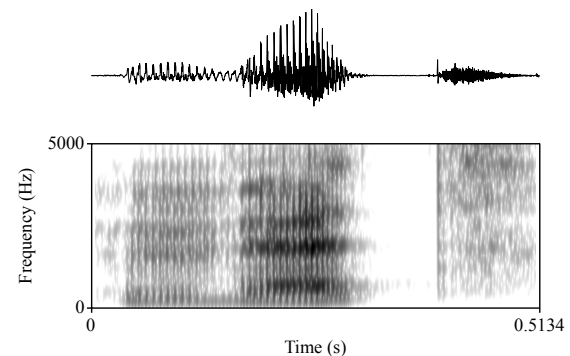

Figure 1: TYPE 1: /vɛt/ 'law' produced with closure, burst, and frication.

On a lenition continuum, TYPE 2 was the least lenited, with closure and frication periods, but no visible or audible burst (Figure 2). Approximately 14% of tokens were classified as this type. They had much shorter closures, averaging 71 ms, but longer frication periods averaging 183 ms. The plosives overall had an average duration of 254 ms.
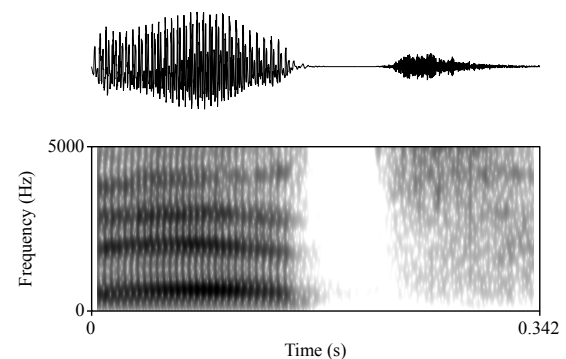

Figure 2: TYPE 2: /eet/ 'eat' produced without a visible or audible burst.

Only 4% of tokens were produced as a TYPE 3, with unclear boundaries between subsegments. Figure 3 shows an example of /boot/ 'boat' with a noisy closure and frication appearing prior to the transient burst spike. The average closure duration for this type was 59 ms, and the average post-burst duration was 195 ms. There were also occasional spectral differences within the frication period, similar to that observed by Mitterer and Ernestus [16]. For example, in Figure 3, there is a difference between the first part of the frication period, with a high amplitude at higher frequencies, and shortly after the burst, with an overall lower amplitude. TYPE 3 realizations had an average overall duration of 255 ms.
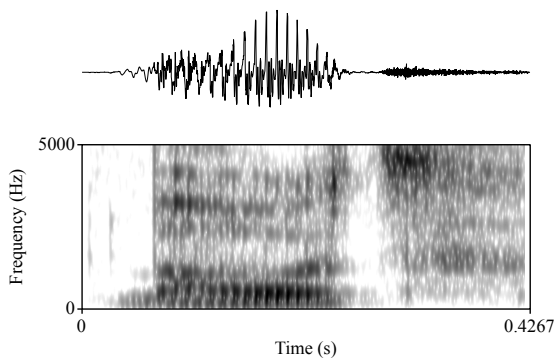
Figure 3: TYPE 3: /boot/ 'boat' produced with frication prior to the transient burst.

Finally, 3% of tokens were fully spirantized (TYPE 4), with no closure or burst, and only a frication period. The average duration of these spirantized variants was the shortest at 212 ms. An example of spirantized /d/ in /eed/ 'oath' is shown in Figure 4.
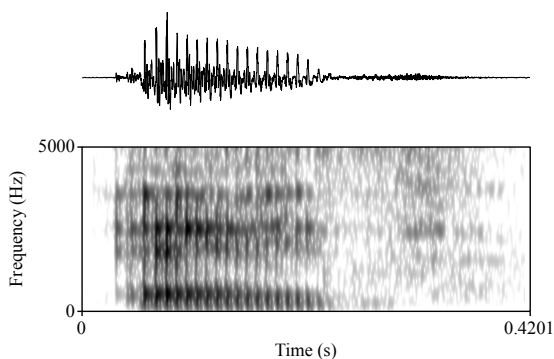
**Figure 4:** TYPE 4: /eed/ 'oath' completely spirantized.

3.2. Conditioning factors

The results of the ordinal logistic regression model are given in Table 1. The t-value is derived by dividing the regression coefficient by its standard error, and conventionally, if the t-value is greater than +2 or less than -2, it is considered significant. Higher t-values indicate higher levels of confidence in the coefficient as a predictor.

First, age group was significant, with younger speakers more likely to produce lenited productions than older speakers (Figure 5). Furthermore, male speakers, both young and old, were significantly more likely to produce lenited tokens than female speakers. Younger male speakers produced the highest amount of lenited plosives overall. Plosive duration was also significant, decreasing as tokens became more lenited, as outlined in the four types in Section 2.2. Neither openness nor frontness of the preceding vowel was significant.

Factor	Log odds	Std E	t-value
/k/	-14.83	1.338e-07	**-1.108e+08***
/t/	-0.25	0.16	-1.53
duration	-0.01	0.001	**-4.38***
younger	1.54	0.19	**8.22***
m gender	0.52	0.17	**3.13***
front V	0.20	0.17	1.16
mid	0.38	0.21	1.80
near-close	0.34	0.32	1.06
open	0.21	0.22	0.95

Table 1: Output of the ordinal logistic regression model.
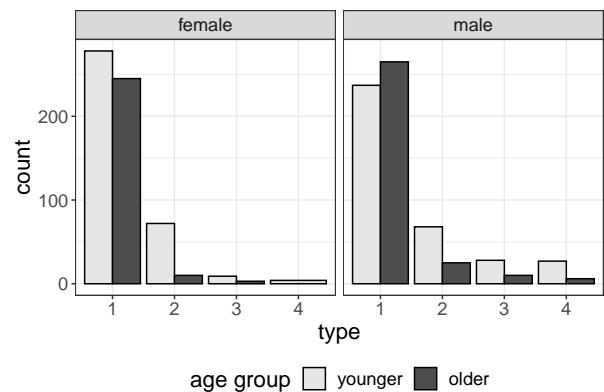
Figure 5: Counts of each lenition type, separated by age group and gender.

There was a significant difference between /d/ and /k/, but not between /d/ and /t/. Overall, /k/ had the fewest lenited realizations, and it had no

instances of complete lenition (TYPE 4). It also had the fewest total tokens due to the structure of the corpus. Notably, both /t/ and /d/ were equally represented and had similar counts of each lenition type. This suggests that the incomplete neutralization in underlying voicing is not becoming a new surface contrast, e.g. [t] versus [t̞].

4. DISCUSSION

All word-final plosives in Standard Dutch can variably lenite in the same general patterns previously reported for /t/ [16]. This lenition also follows the pattern seen in other languages where lenited tokens have shorter durations than non-lenited tokens [1, 5, 6, 7]. Interestingly, the four types of lenition in this study, ordered from a canonical stop to a fricative, had shorter durations at each consecutive step (with one exception of step 2 to step 3, which also differed only by 1 ms). Duration was additionally a significant factor in predicting lenition.

The identity of the plosive was significant, as /k/ lenited less often than its alveolar counterparts. Equal lenition of /t/ and /d/ suggests that the incomplete neutralization is not developing into a new contrast. Instead, all of the word-final plosives are subject to variable lenition.

In terms of social factors, younger speakers and male speakers were significantly more likely to produce lenited tokens. Previous sociophonetic research has shown gender differences in terms of which variants of a sound are used; female speakers tend to use more innovative variants [21], while male speakers are more likely to use non-standard variants [22]. This further provides evidence against the hypothesis that this lenition is a change in progress from a weak incomplete neutralization to a new contrast. Instead, it is more likely that this lenition is simply a stable, non-standard variant in Dutch.

5. CONCLUSION

We present a qualitative and quantitative analysis of word-final plosive lenition in Standard Dutch careful speech. This adds to our knowledge of lenition from previous studies of word-final /t/ deletion in Dutch by quantifying how often each type of lenition occurs as well as the average segmental duration of non-lenited and lenited stops. Furthermore, we present the first sociophonetic analysis of word-final Dutch plosive spirantization, showing that this lenition is both linguistically and socially conditioned. This is a starting ground for future research on Dutch word-final plosive spirantization,

which should include additional social and linguistic factors, especially in casual speech, to better understand what (if any) social meaning is attributed to this process.

6. REFERENCES

[1] U. C. Priva and E. Gleason, "The causal structure of lenition: A case for the causal precedence of durational shortening," *Language*, vol. 96, pp. 413–448, 2020.

[2] J. Katz, "Lenition, perception and neutralisation," *Phonology*, vol. 33, pp. 43–85, 2016.

[3] J. Kingston, "Lenition," in *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*, L. Colantoni and J. Steele, Eds., 2008, pp. 1–31.

[4] E. Buizza and L. Plug, "Lenition, fortition and the status of plosive affrication: the case of spontaneous RP English /t/," *Phonology*, vol. 29, pp. 1–38, 2012.

[5] B. M. A. Rogers and C. A. Mirisis, "Voiceless stop lenition and reduction as linguistic and social phenomena in Concepción, Chile," *Borealis: An International Journal of Hispanic Linguistics*, vol. 7, pp. 187–215, 2018.

[6] J. Katz and G. Pitzanti, "The phonetics and phonology of lenition: A Campidanese Sardinian case study," *Laboratory Phonology: Journal of the Association for Laboratory Phonology*, vol. 10, pp. 1–40, 2019.

[7] D. Bouavichith and L. Davidson, "Segmental and prosodic effects on intervocalic voiced stop reduction in connected speech," *Phonetica*, vol. 70, pp. 182–206, 2013.

[8] C. Gerfen and K. C. Hall, "Coda aspiration and incomplete neutralization in Eastern Andalusian Spanish," 2001, unpublished manuscript.

[9] C. Gerfen, "Andalusian codas," *Probus*, vol. 14, no. 2, pp. 247–277, 2002.

[10] R. M. Kirchner, "An effort-based approach to consonant lenition," Ph.D. dissertation, University of California, Los Angeles, 1998.

[11] I. M. Mees and B. Collins, "A phonetic description of the consonant system of Standard Dutch (ABN), fifth revised edition," *Journal of the International Phonetic Association*, vol. 12, no. 1, pp. 2–12, 1982.

[12] N. Warner, A. Jongman, J. Sereno, and R. Kemps, "Incomplete neutralization and other sub-phonemic durational differences in production and perception: Evidence from Dutch," *Journal of Phonetics*, vol. 32, pp. 251–276, 2004.

[13] M. Ernestus and R. H. Baayen, "The functionality of incomplete neutralization in Dutch: The case of past-tense formation," in *Laboratory Phonology 8*, L. Goldstein, D. H. Whalen, and C. Best, Eds. Berlin, Germany: Mouton de Gruyter, 2006, pp. 27–49.

[14] ——, "Intraparadigmatic effects on the perception of voice," in *Voicing in Dutch: (De)voicing*

- *phonology, phonetics, and psycholinguistics*, J. van de Weijer and E. J. van der Torre, Eds. Amsterdam, the Netherlands: John Benjamins, 2007, pp. 153–173.

[15] A. M. Pfiffner, "Cue-based features: Modeling change and variation in the voicing contrasts of Minnesotan English, Afrikaans, and Dutch," Ph.D. dissertation, Georgetown University, 2021.

[16] H. Mitterer and M. Ernestus, "Listeners recover /t/s that speakers reduce: Evidence from /t/-lenition in Dutch," *Journal of Phonetics*, vol. 34, pp. 73–103, 2006.

[17] M. McAuliffe, M. Socolof, S. Mihuc, M. Wagner, and M. Sonderegger, "Montreal Forced Aligner (Version 0.9.0) [Computer program]," 2017. [Online]. Available: http://montrealcorpustools. github.io/Montreal-Forced-Aligner/

[18] P. Boersma and D. Weenink, "Praat: doing phonetics by computer (Version 6.1). [Computer program]," 2019. [Online]. Available: http://www. praat.org

[19] B. Ripley, B. Venables, D. M. Bates, K. Hornik, A. Gebhardt, and D. Firth, *MASS: Support Functions and Datasets for Venables and Ripley's MASS*, 2023, R package version 7.3-59. [Online]. Available: https://cran.r-project.org/web/packages/ MASS/MASS.pdf

[20] R Core Team, *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria, 2013. [Online]. Available: http://www.R-project.org/

[21] W. Labov, *Principle of linguistic change, Volume 2: Social factors*. Malden, MA: Blackwell Publishers, 2001.

[22] J. L. Fischer, "Social influences on the choice of a linguistic variant," *WORD*, vol. 14, no. 1, pp. 47–56, 1958.