Contrast under pressure: the phonetics of Dutch past tense allomorphy

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ABSTRACT

The Dutch past tense suffix has two allomorphs (*-te* and *-de*) whose selection depends on the voicing specification of the stem-final consonant of the verb. Given that obstruent devoicing is a sound-change-in-progress in Dutch, the stability of this allomorphic pattern is potentially under pressure. We focus on the phonetic informativity of the affix itself and investigate to what extent it contributes to maintaining the phonological contrast.

Based on random forest modelling using multiple phonetic exponents of voicing, we find that the two affix categories are mostly but not entirely separable: 83.6% of tokens in our spoken corpus of 354 (177 - *de*, 177 -*te*) were correctly classified. In terms of variable importance, the phonological contrast is mainly cued by burst duration. While the affix largely preserves the contrast, this finding is striking in the context of traditional descriptions of Dutch as a true voicing language, and it may signal cue restructuring.

Keywords: voicing; sound change; contrast; allomorphy; Dutch

1. INTRODUCTION

Dutch is somewhat exceptional among the Germanic languages since, unlike most of its close linguistic relatives, it is a so-called 'true voicing' or 'prevoicing' language, i.e. its fortis-lenis obstruent contrast is one of zero/short lag VOT vs. prevoiced/negative VOT [9, 12, 2]. For initial plosives, Van Alphen and Smits [15] have shown that the contrast is not reliably made by all Dutch speakers, specifically, that prevoicing was absent for 25% of tokens in their study. Importantly, the phonological distinction between the fortis and lenis categories across languages is known not to hinge solely on the laryngeal features implied by its traditional [±voice]. In addition to vocal fold vibration or phonetic voicing, a number of other features may cue the contrast including duration of the obstruent segment itself, strength and duration of the release burst, and spectral features of the following vowel (see [7] for an overview). Van Alphen and Smits found that perceptually, prevoicing was by far the most important cue despite its frequent absence, but that other cues were indeed present and available to listeners. While Van Alphen and Smits, in attempting to explain their somewhat paradoxical finding, only tentatively suggest it, fifteen years on it appears that obstruent devoicing (effectuated as a diminishing of prevoicing) is in fact a sound change in progress in Dutch. The gradual devoicing of lenis fricatives has in fact been described for almost a century for Standard Dutch in the Netherlands (an overview is in [16]), where /x~ɣ/ have merged for many speakers and /f~v/ are only minimally distinct. In northern dialects, the sound change is near completion, and the fortis-lenis contrast in fricatives is neutralised for many speakers. The devoicing of stops, on the other hand, appears to be an incipient sound change across the Dutch language area [10]. Pinget notes how the stop contrast in her study (/p~b/) has a much higher functional load than the fricative contrast /f~v/, which only serves to distinguish around 10 minimal pairs. This suggests that any change-in-progress affecting prevoicing in stops may not lead to complete neutralisation as easily as that in fricatives due to systemic pressures to avoid extensive homophony [18]. While in her production study, Pinget found the /p~b/ contrast to rely mostly on the presence of prevoicing, she suggests there may be "a trend towards […] a greater reliance on the duration dimension" and her data include individuals who already show such greater reliance.

As opposed to the studies discussed above, which concern word-initial obstruents in free morphemes, our focus is on the effects of the sound change on a bound morpheme in a word-internal context. Specifically, we examine if and how the on-going neutralisation interacts with the morphophonological process of past tense formation. In Standard Dutch, the regular, productive past tense is formed by adding a suffix to the verb stem. The suffix takes the form -*te* /tə/ or -*de* /də/, depending on the phonological specification of the stem-final consonant of the verb as fortis/voiceless or lenis/voiced, respectively. By focusing on the affix itself we are able to study the potential effect of a phonetic change on a morphophonological process that hinges on the contrast that is neutralising. At the same time we avoid the issue of potentially destructive homophony at the lexical level, which is likely to impede progress of the change. Given the more than occasional absence of prevoicing observed in earlier studies, we

predict the two allomorphs to display incipient merger, at least along the voicing dimension.

2. METHOD

2.1. Corpus

Dutch past tense allomorphy has recently been examined for another reason: speakers have been found to make 'errors', i.e. choose the allomorph with the opposite voicing specification to the stem-final consonant of the verb. Ernestus and Baayen [3, 4] have shown that these 'mismatches' are modulated by lexical frequency and neighbourhood density: less frequent verbs are more often mismatched, and verbs with many phonologically similar neighbours with an opposite voicing specification for their stem-final consonant are more often mismatched. While our corpus containing elicited Standard Dutch past tense forms was originally assembled to study the acoustic characteristics of these types of mismatches, we focus here on words for which allomorph selection is expected to be relatively unproblematic. To this end, we selected all tokens of seven verbs that are both relatively frequent (log frequencies in CELEX 6.0-8.8 as established in [3], the range in our larger corpus being 0.0-8.8) and have relatively many phonologically similar neighbours with the same voicing specification for the stem-final consonant (75-99%, the range in the larger corpus being 1-99%). For each of these, we also selected their closest phonological neighbour in the database with a stem-final consonant with the opposite voicing specification, yielding the set in Table 1 below.

Table 1: List of verbs used in the study (l-r: infinitive in Dutch orthography; verb stem in IPA; English gloss). Verbs in the left half of the table have a lenis stem-final consonant; those directly opposite on the right are their closest phonological neighbours with a fortis stem-final consonant at the same place of articulation.

Lenis (-de)			Fortis (-te)		
beven	beʋ	'tremble'	blaffen	blɑf	'bark'
hoeven	huʋ	'need'	poffen	pɔf	'puff'
durven	dʏrʋ	'dare'	surfen	sʏrf	'surf'
deinzen	dɛinz	'recoil'	dansen	dɑns	'dance'
reizen	rɛiz	'travel'	eisen	ɛis	'demand'
leggen	lɛɣ	'lay'	kuchen	kʏx	'cough'
vegen	veɣ	'pant'	juichen	jœyx	'cheer'

The number of minimal pairs (and even near-minimal pairs such as *eisen~reizen*) is extremely small, which is why phonological nearness is determined by more abstract aspects of the syllable structure, and limited to place and manner of articulation of the stem-final consonant in the first two cases.

The recordings come from nine female speakers of Standard Dutch (age range: 18-21, all students at Utrecht University at the time of recording) who heard a male speaker of Standard Dutch produce third person singular present tense verb forms in a frame sentence (*Hij* [VERB]+*t helemaal niet*, 'He does not [VERB]$_{3sgpr}$ at all'). In the singular present tense, the stem-final consonant is subject to phonological final devoicing, so that the voicing contrast is neutralised or near-neutralised [17], and listeners have to recover the underlying voicing specification of the stem-final consonant of the verb. The subjects were asked to repeat the frame sentence directly after hearing the prompt, while changing the verb to its past tense form. Irregular verbs, for which past tense formation does not involve affixation, were added as distracter items. Three repetitions of the list in three different orders were recorded for each speaker.

2.2. Analysis

The past tense suffixes were segmented manually and subsequently analysed with respect to a number of potential phonetic parameters of the forts/lenis contrast. The following measurements were included: stop closure duration, voicing ratio (the duration of vocal fold vibration relative to the duration of closure), burst duration, the duration of the following vowel (/ə/), as well as the f0 and f1 at 10 ms and 20 ms after its onset. We excluded the mean intensity of the stop burst from the analysis (included in [15]) because not all tokens contained a burst, therefore we could not measure burst intensity consistently for all the tokens.

In order to assess the relative contribution of various phonetic dimensions to maintaining the contrast, we used random forest modelling, implemented in the R package `party` [5]. A random forest was fitted to predict the affix (*-te* or *-de*), based on 354 tokens of the verbs in the subcorpus (9x14x3=378, with 24 tokens excluded because of mispronunciations due to speech errors or mishearing of the prompt). All the predictors listed above were entered. We determined variable importance, using the default options in the `varimp()` function, and the conditional permutation importance [13, 14]. The accuracy of the model was tested by applying it to classify all tokens in the same data set and comparing the classification to the underlying (target allomorph) categories.

3. RESULTS

3.1. Classification

As shown in Table 2, the model was able to correctly classify 296 (140+156) out of the 354 tokens (83.6%)

with respect to the target allomorph. It incorrectly classified 37 tokens with a *-de* target as fortis (20.9%) and 21 tokens with a *-te* target as lenis (11.9%). The two categories are in other words largely but not completely separable on the basis of the phonetic predictors.
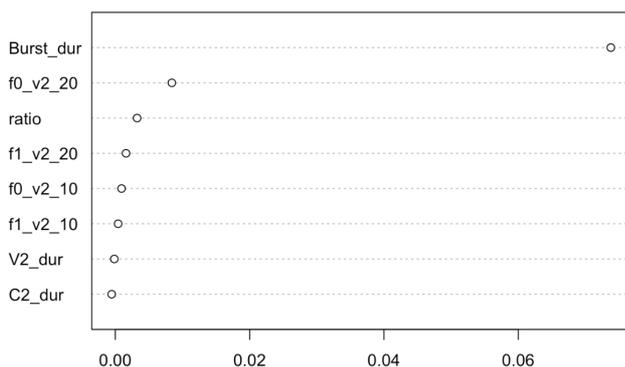
	Predicted	*-de*	*-te*
Target			
-de		140	37
-te		21	156

3.2. Variable importance

Figure 1 shows the relative importance of the cues that served as phonetic predictors in the classification.

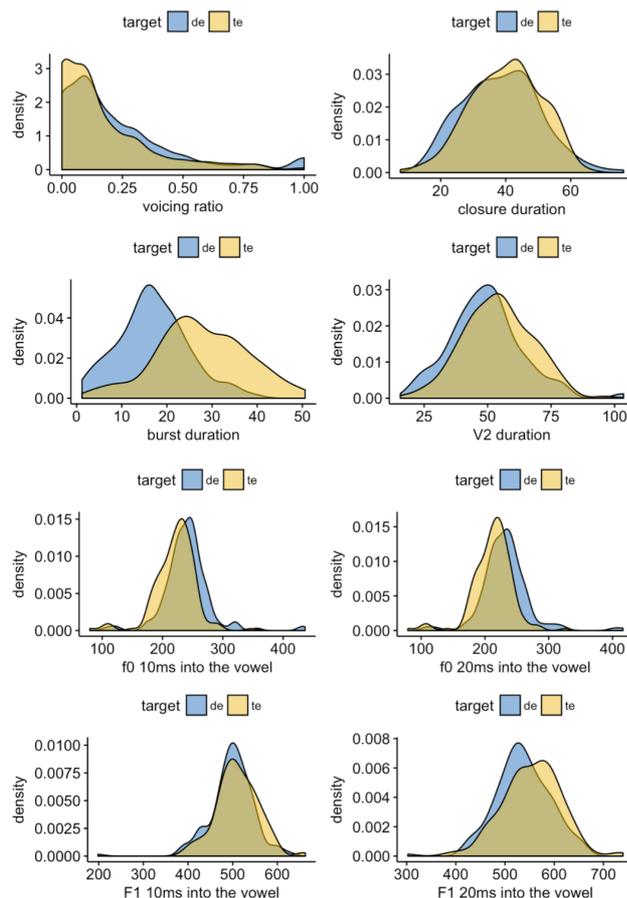**Figure 1**: Variable importance for each of the phonetic predictors in the model.

By far the most important contributor to the classification is the duration of the stop burst. It is followed, at considerable remove, by f0 at 20 ms into the vowel. The contributions of all remaining predictors, including voicing ratio, our measure of phonetic voicing, are close to zero.

3.3. Separability of phonetic cues to the fortis-lenis contrast

Density plots for each of the phonetic predictors further elucidate the result of the variable importance analysis. All of the phonetic cues except burst duration show near-complete overlap for the two categories. Note that these are target allomorph categories, not those formed by the statistical model. Despite having the most strongly divergent distributions, even burst duration shows considerable overlap. (Note that the distributions for the second-most important contributor to the classification, f0 at 20 ms into the following vowel, separate in the unexpected direction: both f0 and f1 have been found

to be higher (and shifting downwards) for voiceless stops relative to voiced ones [8, 1, 7]. F1, but not f0, appears to follow that pattern here, to the extent that there is any pattern discernible in these overlapping distributions.)

Figure 2: Density plots for the phonetic predictors according to target category

4. DISCUSSION

4.1. Devoicing and contrast

The most immediately striking result from the analysis is the near-complete overlap with respect to phonetic voicing (as determined by voicing ratio) for the two target allomorphs. This overlap includes some *-te* targets realised with a large degree of voicing (50% or more). It is reasonable to assume that these encompass cases of 'mismatched' allomorph selection (prescriptive *-te* targets realised as *-de*). Crucially, this is not reciprocal in the sense that the number of *-de* targets realised as voiceless is not also a small minority; instead, phonetic voicing is absent from or only minimally present in the majority of tokens with a *-de* target. This shows that it is an even less reliable cue than noted in previous literature. While there may therefore be mismatched allomorphs (*-de* targets realised as *-te*) in the data, there are

simply too few tokens with sufficient amounts of voicing in the entire dataset for it to contribute to the assignment of category membership. In other words, at least in this particular prosodic and morphological context, there is no contrast between /t/ and /d/ in terms of phonetic voicing, and the merger with respect to this phonetic parameter is towards the voiceless category.

Despite the overlap in voicing ratio and most other cues, the model performs reasonably well in separating the two target categories at an 83.6% success rate. It achieves this classification result by relying mostly on the duration of the release burst. The importance of this cue for maintaining the contrast is striking, given the previous literature: while it is routinely mentioned as one of the cues to the Dutch fortis-lenis contrast, it has not been considered a particularly important one. Pinget does not consider it as a separate cue, using total consonant duration instead. Place of articulation may be of relevance here: Van Alphen and Smits found that both in production and perception, burst duration appears somewhat more important for alveolars than for labials, as the former "seem to carry more of the voicing distinction in the burst than labial plosives do" [15].

4.2. Predicting the future of the fortis/lenis contrast

Despite the absence of real-time or apparent-time comparisons, our data have potential implications for the development of devoicing as a sound change in progress. The combination of the lack of a true prevoicing contrast and the fact that the classification is still mostly successful when it relies on burst duration suggests there is one of two potential scenarios unfolding: the contrast between the categories may be gradually neutralising, and this is due to the most important cue to the contrast falling away. Perhaps burst duration will be too unreliable a cue to carry the contrast alone, with around 16% of our data already being misclassified. Of course, our study concentrates on the phonetic informativity of the past tense affix itself, and the recoverability of the contrast for the cluster as a whole (stem-final obstruent plus affix-initial stop) may be higher; on the other hand, stem-final obstruents and fricatives in general are among the prime devoicing targets in Dutch.

Another possibility is that the contrast is a little unstable, but will ultimately be preserved: recall that the past tense suffix may be a context in which the /t~d/ contrast is not particularly informative, but its functional load in other contexts is high. In that case, we may be seeing cue restructuring taking place, and the very earliest stages of Dutch moving from a true voicing language to an aspiration one. This is highly speculative at this point: there is at present no evidence that we are aware of that aspiration (in terms of long lag VOT) is starting to appear in stressed contexts in free morphemes in Standard Dutch. On the other hand, if it is an incipient change, it may be able to take hold in a less salient context such as the unstressed word-internal one examined here first.

4.3. Past tense allomorphy

In general, it is important to stress again that the context we have studied is highly specific, phonologically as well as morphologically. Past tense formation in Dutch has excited phonologists for many years: it is problematic for the so-called 'laryngeal realism' approaches to abstract feature specifications in that it appears to involve 'active' spreading of voicelessness (that is, the initial stop of the affix assimilates to a preceding fortis stem-final consonant), which is predicted not to be possible in prevoicing languages [6]. The relevance of this debate hinges on whether the allomorphic alternations involved in past tense formation are primarily analysed as phonological (there is a single past tense morpheme and the laryngeal specification of its initial stop is derived through spreading from the verb stem) or lexical (both forms are available in the lexicon and selection is determined by phonological characteristics). More recently, the studies by Ernestus & Baayen discussed above have shown how the phonological regularity of the process is often overruled by aspects of lexical analogy. What Ernestus & Baayen did not explore is how the mismatches created by affixing the 'wrong' allomorph are realised phonetically, but there is evidence that at least some realisations are indeterminate, involving features of both the fortis and lenis categories [11].

What seems likely in any case is that there are confluent pressures on the contrast in this context: there is the structural process of final devoicing which exerts an influence on the realisation of the final consonant in the verb stem; there is the general devoicing of fricatives in all contexts in the language, and there is the early-stages change of stop devoicing. These may all contribute to the overlap we find for almost all phonetic cues to the fortis-lenis contrast.

5. CONCLUSION

The allomorphy associated with past tense formation in Dutch is under pressure due to the relative dearth of robust cues to the fortis-lenis contrast in this context. Phonetic voicing appears to play no role at all, while burst duration emerges as the most important cue. Whether this is the earliest stage of

more general cue restructuring pertaining to the Dutch fortis-lenis contrast remains to be seen, but devoicing as a sound change in progress, both that of fricatives and – however incipient – that of stops, may have a far-reaching impact on Dutch morphophonology.

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