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Voicing distinctions in the Dutch-German dialect continuum

Abstract

This study investigates the phonetics and phonology of voicing distinctions in the Dutch-German dialect continuum, which forms a transition zone between voicing and aspiration systems. Two phonological approaches to represent this contrast exist in the literature: a [\pm voice] approach and Laryngeal Realism. The implementation of the change between the two language types in the transition zone will provide new insights in the nature of the phonological representation of the contrast. In this paper I will locate the transition zone by looking at phonetic overlap between VOT values of fortis and lenis plosives, and I will compare the two phonological approaches, showing that both face analytical problems as they cannot explain the variation observed in word-initial plosives and plosive clusters.

Keywords: dialectology, phonology, phonetics, Laryngeal Realism, transition zones

1. Introduction

Voicing distinctions in plosive systems have been studied extensively in phonology. Lisker & Abramson (1964) discovered that the phonetic realisations of ‘voiced’ and ‘voiceless’ plosives are not identical across languages: in word-initial position fortis and lenis plosives can be distinguished in different ways with respect to Voice Onset Time (VOT; describing the onset of vocal fold vibration relative to the moment of plosive release). Languages contrasting two plosive series typically contrast prevoiced plosives with plain voiceless plosives (voicing languages), or plain voiceless plosives with voiceless aspirated plosives (aspiration languages). The boundary between plain voiceless and aspirated plosives is placed around 20-35 msec (depending on Place of Articulation (PoA)) by Keating (1984):

(1)	voicing languages		aspiration languages
lenis	/b/ /d/ /g/		/p/ /t/ /k/
fortis	/p/ /t/ /k/		/p ^h / /t ^h / /k ^h /

Other possibilities are languages contrasting prevoiced with aspirated plosives (e.g. Swedish: Beckman et al. 2011. However, this system does not occur frequently), or languages contrasting all three categories (e.g. Thai: Lisker & Abramson 1964).

Other differences between the two systems concern voicing of intervocalic lenis plosives: in voicing languages these are always fully voiced, whereas in aspiration languages they can be either fully or partially voiced (Beckman et al. 2013). Full voicing in the latter case is argued to be an effect of phonetics (spontaneous voicing) rather than phonology. Finally, the two systems show differences in assimilation patterns. In voicing languages plosive clusters assimilate to a lenis C2, while in aspiration languages they assimilate to a fortis C2 (e.g. Iverson & Salmons 1995).

Traditional analyses of both language types involve a [\pm voice] distinction (e.g. Wetzels & Mascaró 2001). Lenis plosives are marked as [+voice], fortis plosives as [-voice].ⁱ The phonetic differences between the two systems are argued to be the result of language-specific phonetic implementation. Such an approach has several disadvantages. First, phonetic patterns (prevoiced vs. short-lag in voicing languages, short-lag vs. long-lag in aspiration languages) are not systematic: since [+voice] can represent prevoiced or plain voiceless plosives, and [-voice] can represent plain voiceless or voiceless aspirated plosives, phonology predicts that languages contrasting prevoiced with aspirated plosives are just as frequent as voicing and aspiration systems.ⁱⁱ Second, the approach fails to explain why only lenis (prevoiced) plosives are phonologically active in voicing languages whereas

only fortis (aspirated) plosives are phonologically active in aspiration languages. Some authors (Halle & Stevens 1971; Iverson & Salmons 1995, 1999 a.o.) therefore propose a phonological difference between the two systems: in voicing languages lenis plosives are marked as [voice], while fortis plosives are unmarked. In aspiration languages lenis plosives are unmarked while fortis plosives are marked as [spread glottis] ([sg], referring to the position of the glottis at the moment of plosive release). The approach has been named 'Laryngeal Realism' (LR) by Honeybone (2005). In this approach the phonetic and phonological differences are explained by the different features: VOT differences are explained by markedness differences (unmarked plosives have short-lag VOT in both systems, but marked plosives have VOT values corresponding to their phonological features), and phonological differences are explained by the presence of different features (assimilation is always in the direction of the present feature).

In this article I study the change between voicing and aspiration systems in the Dutch-German dialect continuum. Both systems are present in the continuumⁱⁱⁱ (and the standard languages are voicing (Netherlands) and aspiration (Germany) languages (Lisker & Abramson 1964; Jessen & Ringen 2002), which provides us with an interesting testing ground for the phonological analysis of voicing distinctions. Because LR claims a link between phonological features and phonetic values, a phonetically gradual change would be unexpected. Rather, one would expect (a) an immediate change between the two systems (without a transitional area), or (b) an intermediate area that cannot be characterised as either a voicing or aspiration system. Since LR assumes that speakers only have the features [voice] and [sg] (and unmarked [Ø]) at their disposal, speakers in the transition zone must make use of the same features. The only two other scenarios LR

is logically able to deal with are an area where [voice] and [sg] are absent (i.e. an area with only one, phonologically unmarked, plosive series), or an area where [voice] and [sg] are both present. This latter scenario means that the boundary between unaspirated and aspirated fortis plosives is located more westward than the boundary between voiced and unaspirated lenis plosives. A [\pm voice] analysis does not pose any restrictions on the phonetic realisation of both plosive series, so both a gradual and an immediate phonetic change between the two systems are possible scenarios.

In this paper I will show that a transition zone can be identified, and where it must be located. I will present the results of word-initial VOT measurements and percentage of voicing during closure in plosive clusters (for the assimilation context), and discuss the phonetic and phonological characteristics of the continuum. I will show that a gradual phonetic change can be found, and argue that the data presented here pose problems for both frameworks.

2. Methods

The data in this study come from different databases. For dialects spoken in the Netherlands I used the GTRP-database (Goeman-Taeldeman-Van Reenen-Project), which contains recordings of a word list translated into dialect. For the dialects spoken in Germany I used recordings of the Wenker sentences (collected from the REDE, NSD, MRPAD and MRDD databases; all data are based on the same questionnaire. For an example, see <http://regionalsprache.de/SprachGis/Map.aspx>).^{iv} These are recordings of sentences translated into dialect. All informants are dialect speakers, either male or female (standard language proficiency is unknown). Speakers' age ranges between 21 and 82 years old at

the time of recording; recordings were made between 1981 and 1990 (Netherlands) and between 1956 and 1987 (Germany) (some ages and recording dates are unknown). The study includes 104 locations, 40 in the Netherlands and 64 in Germany (figure 1).^v For most locations there was one informant; for some German locations there were two. Because these speakers sometimes showed different behaviour, both were included in the study (excluding one speaker might influence the overall pattern).



Figure 1 Locations

The plosives <b, d, p, t, k> are included in this study (since the phonological status of the plosives is the topic of the study I use orthographic labels, which are consistent across the continuum). <g> is excluded because it is absent from several of the dialects, so its phonetics and phonology cannot be compared across the entire continuum. For every location at least one item per plosive was selected, with that plosive in word-initial position. All plosives appear in the onset of a stressed syllable and are preceded by a pause

(prevoicing is difficult to measure if a plosive is preceded by another voiced segment, as voicing offset and onset in the two segments cannot be identified).

For the assimilation context items with two adjacent plosives have been selected. Because of the scarcity of the databases, the plosives are separated by a word boundary rather than a syllable or morpheme boundary. The lenis-fortis value of C2 was controlled: for every location at least one item with a lenis C2 and one item with a fortis C2 was selected. The value of C1 could not be controlled, as the databases are scarce. However, since all varieties have Final Devoicing (Van Oostendorp 2007, Lindow et al. 1998), both lenis and fortis C1's can (but do not have to) surface as lenis only when followed by a lenis C2.

Measurements were carried out in Praat 6.0.12 (Boersma & Weenink 2016). Voice onset was placed at the first visible wave in the waveform, combined with the onset of the black horizontal bar in the spectrogram. Closure release was placed at the point of a sudden change in amplitude in the waveform, combined with the presence of a black vertical bar in the spectrogram. VOT (in milliseconds) was calculated by subtracting the moment of release from the moment of voice onset.

For the assimilation items percentage of voicing during closure was measured. Closure onset was placed at the moment where the formants were no longer clearly visible, combined with a significant decrease in amplitude in the waveform. Closure offset was placed at the release of the second plosive. Voicing offset was placed at the end of the last visible wave in the waveform, combined with the offset of the black horizontal bar in the spectrogram. Voicing onset coincides with closure onset. For all methods, cf. a.o. Lisker & Abramson (1964) and Van Alphen & Smits (2004).

3. Results

In figures 2-6 plots of the word-initial VOT values are presented. The x-axis represents the geographical longitude of each location (starting around 5°, the approximate longitude of the westernmost location), the y-axis represents the observed VOT value. Visual inspection of these plots shows a gradual increase in VOT values for each plosive: lower values are found in the west, higher values in the east, and no sudden changes are visible. To test if VOT and coordinates are correlated, a Spearman's Rank-Order Correlation test was calculated for all plosives (a Pearson's Product Moment Correlation was inappropriate because the coordinate values are not normally distributed^{vi}). This revealed a significant, positive correlation for all plosives (since the transition zone might display unexpected patterns (e.g. extreme VOT values), outliers were not removed). R- and p-values are given below each figure.

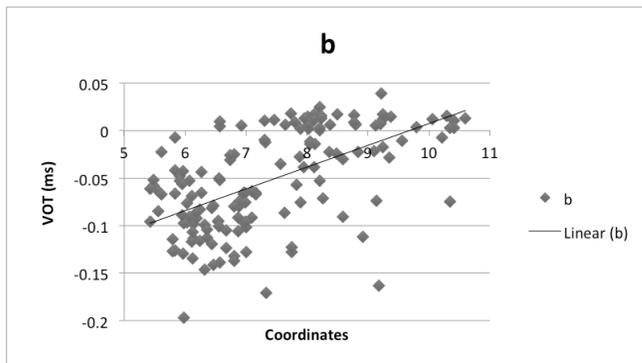


Figure 2 , $r_s = 0.581446$, $p = 6.105e-15^*$

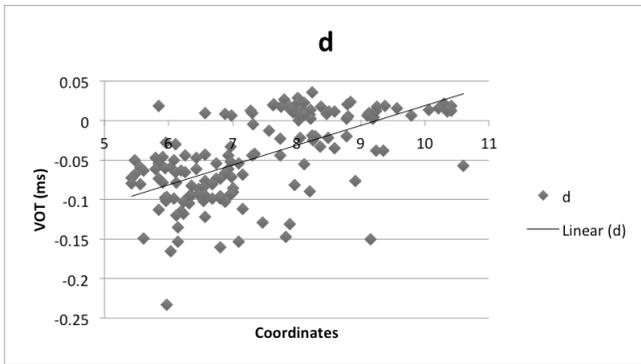


Figure 3 <d>, $r_s = 0.619174$, $p < 2.2e-16^*$

The graphs for the lenis plosives (figures 2-3) show an abundance of prevoicing in the west of the continuum (between 5° and 7°). The eastern end (approximately from 9°), however, shows mostly positive VOT's, while in the middle area shows both prevoicing and positive VOT's. The VOT values for the fortis plosives (figures 4-6) have a less clear distribution:

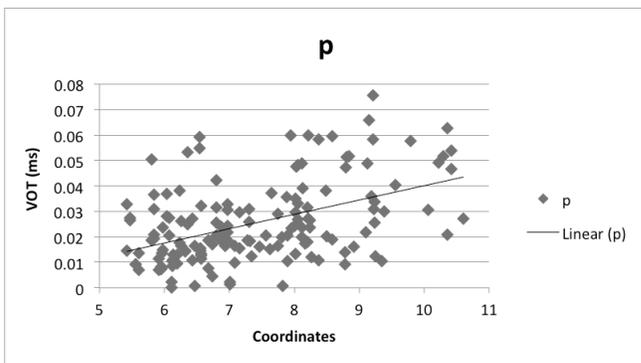


Figure 4 <p>, $r_s = 0.4180859$, $p = 8.345e-08^*$

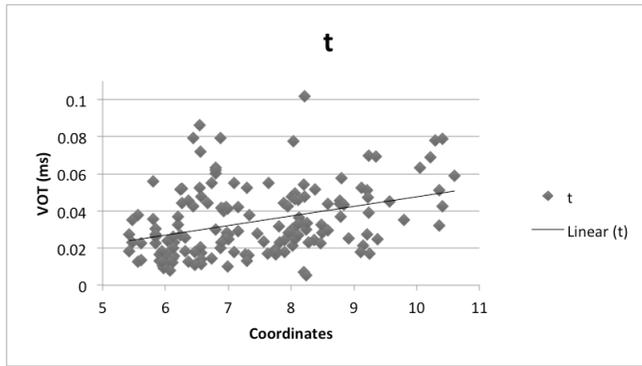


Figure 5 <t>, $r_s = 0.3690651$, $p = 2.477e-06$ *

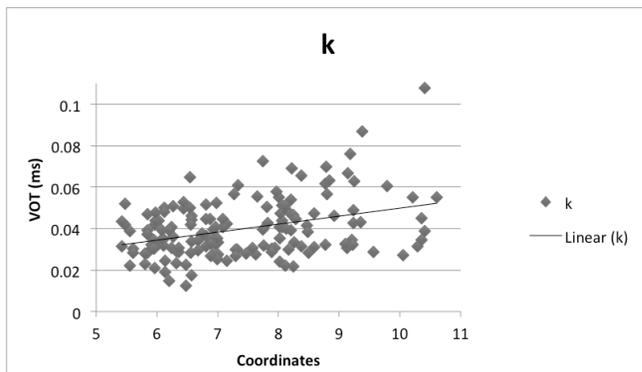


Figure 6 <k>, $r_s = 0.2841582$, $p = 0.0003393$ *

An eastern area with aspiration (VOT of > 30 msec) is visible, but the west and middle are not clearly distinguishable: both areas show short-lag and long-lag VOT values. However, a transition between the two outer ends of the continuum is still visible.

The VOT data are supported by the assimilation data (figures 7-8), where percentage of voicing is plotted against longitude coordinates. Based on visual inspection, the continuum can be divided into three different areas: a western area with full voicing of lenis C2 clusters (74 items) and partial voicing of fortis C2 clusters (54 items), and an eastern area with partial voicing of both cluster types (28 resp. 12 items). The middle area, however, shows a different pattern: both cluster types (99 resp. 52 items) can show full intervocalic voicing, but it is inconsistent in both cases.

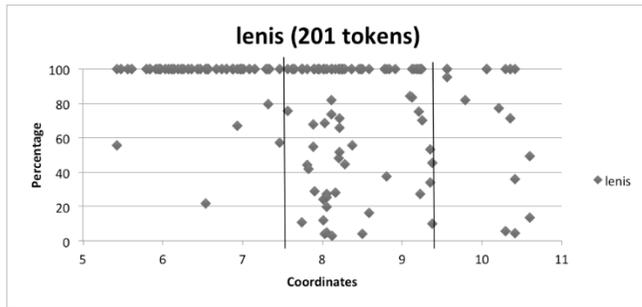


Figure 7 Assimilation (lenis C2)

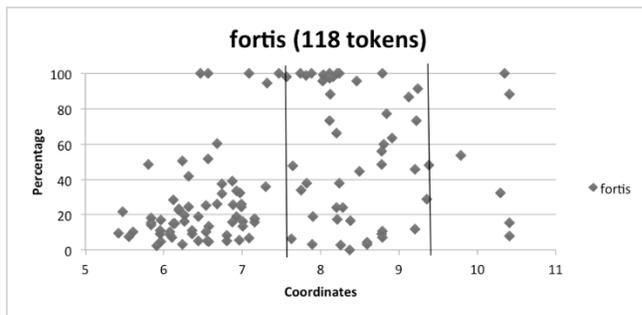


Figure 8 Assimilation (fortis C2)

Figures 2-3 and 7-8 show a tripartite division of the continuum, the easternmost area of which is also visible in figures 4-6. Figures 2-6 also show a gradual transition between voicing and aspiration systems. It is, however, difficult to determine the location of the transition zone, since variation is abundantly present: especially for fortis plosives where the west and middle show both short-lag and long-lag VOT values. Variation is the only characteristic based on which these plots could reveal the transition zone, but if it is present in the entire continuum, the transition zone cannot be located. A better picture is given in figures 9-10, where, per PoA, fortis and lenis VOT values are plotted in one graph, to show how the two categories pattern with respect to one another. Diamonds represent lenis values, squares represent fortis values. An overlap plot for <k> is missing since the study does not include <g>.

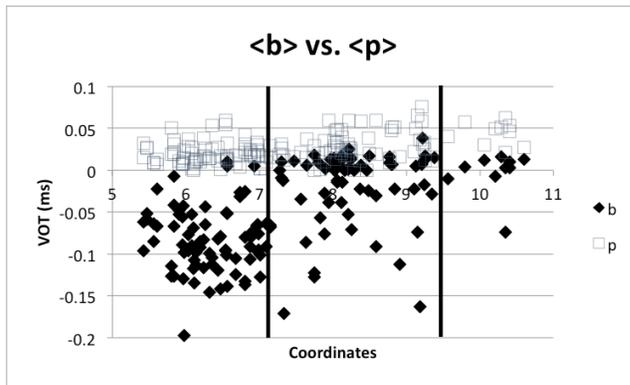


Figure 9 Overlap -<p>

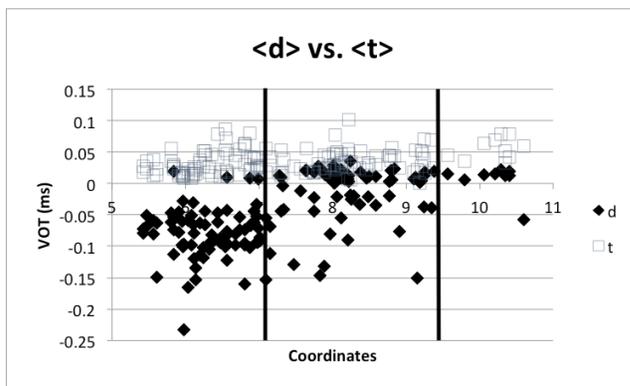


Figure 10 Overlap <d>-<t>

Both overlap plots can visually be divided into three areas: two stable areas (in the west and east) with distinct lenis and fortis VOT values, and one instable area in the middle with phonetic overlap. In the west, the two series can clearly be distinguished around a VOT of 0 msec, in the east around 20-30 msec (the lowest fortis VOT values). The instability in the middle area hints at a change between the two systems, meaning that the transition zone is characterised by phonetic overlap. However, the west shows some minor overlap as well. Van Alphen (2007) argues that prevoicing is phonetically difficult to produce, and shows that approximately 25% of word-initial plosives in Standard Dutch are realised without prevoicing. In the present study, 7 out of 160 lenis ‘Dutch’ plosives (4.375%) are realised

voiceless: much less than 25%. The overlap in the western area might thus be due to the same effect.

However, the data scarcity is problematic. For many locations only one item per plosive was found, sometimes even no item at all. It is thus difficult to make an informed decision about underlying features for single locations. Furthermore, the scarcity makes it impossible to normalise VOT values for speaker's sex, speech rate (word list vs. phrases might cause a difference in speech rate; see also section 4), etc. To overcome these problems a clustering procedure is used whereby the entire continuum is divided into a number of arrays. Per array average VOT values per plosive are calculated. The size of the arrays is based on coordinates; the number of locations varies per array. For each array the average VOT values of both the lenis and fortis plosive are plotted; error bars indicate the lowest and highest VOT values. Plots are shown for 10 arrays (the optimal number of arrays has yet to be determined); figure 11 shows VOT values for -<p>, figure 12 for <d>-<t>. If we take the onset and offset of phonetic overlap to be the onset and offset of the transition zone, we see that for both PoA's overlap is present between the coordinates 7.5° and 9°.

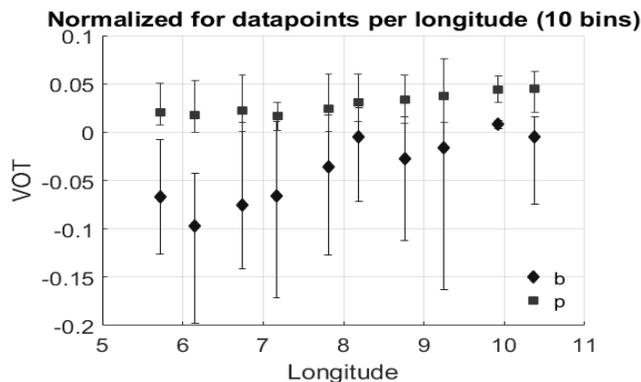


Figure 11 Overlap -<p> - 10 arrays

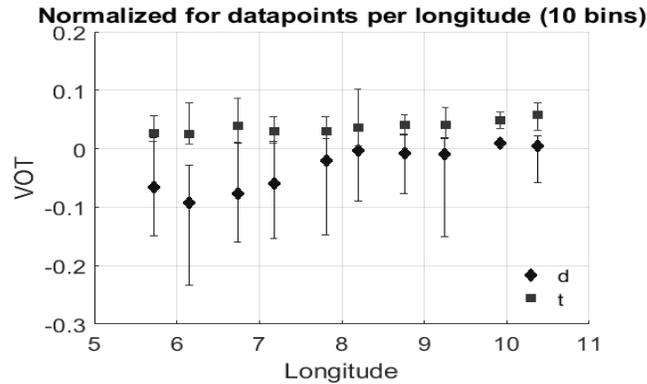


Figure 12 Overlap <d>-<t> - 10 arrays

4. Discussion

The present study shows that the change between voicing and aspiration varieties in the Dutch-German dialect continuum is phonetically gradual. The transition zone can be identified by looking at overlap in VOT values, which is present in the transitional area but absent from areas with consistent prevoicing or aspiration. The location of the transition zone is further supported by the behaviour of plosive clusters, where we find inconsistent full voicing of both cluster types. In this section I will go into the details of analyses in terms of $[\pm\text{voice}]$ and LR, but first I will address a more general problem.

The western border of the transition zone roughly coincides with the Dutch-German political border. One might therefore argue that the transition zone is an effect of standardisation in two different directions or of the different databases: the Dutch database contains word list translations, while the German database contains sentence translations. The difference between words and sentences triggers different speech rates, which has an effect on VOT values (e.g. Beckman et al. 2011). However, if speech rate has an effect on VOT, prevoicing and aspiration tend to be exaggerated while short-lag VOT is unaffected. Since in the transition zone VOT values do not seem to be exaggerated, a speech rate effect

is unlikely. There might, however, be a database effect caused by differences in recording date: dialects in Germany were recorded between 1956 and 1987, dialects in the Netherlands between 1981 and 1990. The dialects in the Netherlands thus might have undergone more standardisation than the dialects in Germany (which would predict the consistent prevoicing and assimilation on the Dutch side of the border). This effect might be argued to be problematic for the analysis, but the transition zone extends well into Germany (past the city of Soltau). Therefore, even if the beginning of the transition zone is partly an effect of standardisation or of the different databases, the end of the transition zone is not. The existence of the transition zone therefore cannot be questioned.

As we have seen in the plots, the western area shows consistent prevoicing of lenis plosives and assimilation to a lenis C2 in clusters. This is consistent with both a $[\pm\text{voice}]$ and a $[\text{voice}]/[\emptyset]$ system. The fortis plosives, however, are realised with either short-lag or long-lag VOT, while in typical voicing systems they are realised with short-lag VOT. If the west is a voicing area, the presence of aspirated fortis plosives has to be accounted for. In a $[\pm\text{voice}]$ system this realisation is unproblematic, as $[-\text{voice}]$ plosives are realised with long-lag VOT values in aspiration languages. Nothing prohibits the same realisation of $[-\text{voice}]$ plosives in voicing languages. For LR the long-lag realisations might be considered more problematic, as these are associated with $[\text{sg}]$ -marked instead of unmarked fortis plosives. However, Avery & Idsardi (2001) argue that a laryngeally unmarked plosive may show variation in VOT values, as there is no laryngeal feature triggering specific phonetic values. The presence of aspiration on fortis plosives is thus not that problematic, and might even be expected considering the presence of surrounding aspirating dialects and the absence of a phonological feature. The presence of a small number of voiceless lenis

plosives has already been discussed in the previous section, and is argued to be the result of a phonetic difficulty to produce prevoicing (Van Alphen 2007). The data here should thus not be considered problematic for either approach.

The eastern area shows short-lag VOT on lenis plosives, consistent aspiration of fortis plosives, and no assimilation to the lenis member of the cluster; a pattern which is consistent with a [sg]/[Ø] approach. The absence of voice assimilation is expected because of the absence of a feature [voice]. However, the pattern is less consistent with a [±voice] approach, as the absence of voice assimilation is difficult to explain in the presence of the feature [+voice]. In both approaches the presence of prevoiced lenis plosives is not unexpected: in a [±voice] analysis nothing prohibits [+voice] plosives in an aspiration system from being prevoiced, as they also surface as prevoiced in a voicing system. In a [sg]/[Ø] analysis the lenis plosives are laryngeally unmarked and can therefore show phonetic variation (cf. fortis plosives in voicing systems).

The middle area shows less clear patterns. In the previous section I have shown that the two series show considerable phonetic overlap. Within LR, the area can be analysed as having only one plosive series. As there is no laryngeal feature present, plosives can be realised with varying VOT values. This approach is further supported by the behaviour of plosive clusters, where full voicing is inconsistently present in both cluster types. If a feature [voice] were present, assimilation should be consistent across clusters with a lenis C2, and if a feature [sg] were present it should block full voicing in clusters with a fortis C2. As both full and partial voicing are present in both clusters, it is most likely that neither feature is present, allowing for full intervocalic voicing of plosive clusters (a phonetic process).

Looking at the cluster plots one might argue that the transition zone must be a voicing area rather than an area with only one plosive series, as most of the average values are negative. However, the raw data (figures 2-6) show that a large number of lenis plosives is realised without prevoicing. The resulting prevoiced VOT values in the geographical arrays are an effect of averaging small (close to zero) short-lag VOT values and larger prevoiced values: if an average is calculated the result will always be negative if the prevoiced value is bigger than the short-lag VOT value. So, the seemingly consistent prevoicing in the transition zone is merely an averaging effect.

Several points are problematic for the 'no feature' approach. First, while fortis and lenis plosives show considerable phonetic overlap in the transition zone, most individual speakers make a distinction between the two series: in only 7 cases (all in the middle area) is a fortis plosive realised with a shorter positive VOT than its lenis counterpart. Second, the clustering analysis shows a separation of average fortis and lenis values.^{vii} Finally, the two plosive series do show some stability: lenis plosives are not aspirated,^{viii} and fortis plosives are not prevoiced. If there is indeed one plosive series, this patterning is unexpected. A [\pm voice] approach, however, has no difficulty accounting for this observed pattern. As VOT values are the result of language-specific implementation rather than being linked to phonological features, the variation and gradual increase in VOT values in the transition zone can be accounted for. A [\pm voice] approach therefore appears more suitable to explain the observed patterns. However, the assimilation data do not fit the analysis. First, if [+voice] triggers assimilation in the west it is unclear why it does not do so in the east and middle, and why the feature [-voice] is inactive in the entire continuum. Second, if the middle area shows a [\pm voice] distinction, it cannot be explained why both

features display the same unexpected phonological behaviour (both cluster types show inconsistent full voicing, so both features are inconsistently phonologically active: [+voice] is expected to trigger assimilation, which it does only inconsistently; [-voice] is expected to block assimilation, which it only does inconsistently too).^{ix}

In conclusion, both approaches face difficulties. As fortis and lenis plosives seem to be distinguished in the transition zone, the [\pm voice] approach seems favoured over LR, but the assimilation data are in favour of LR (no feature). However, the present analysis only looks at VOT, while several other phonetic variables, such as duration of the burst or F0 of the following vowel (e.g. Van Alphen & Smits 2004), have been shown to play a role in this distinction as well. It will be interesting to see if these variables show the same pattern as VOT. If no other variables distinguish the two series, both analyses will have to be modified to be able to represent the contrasts found in the transition zone. LR claims a strong link between phonetics and phonology, but as the data in the transition zone have proven this wrong, this claim will have to be departed from (cf. Hamann & Seinhorst 2016). [\pm voice] will have to find a way to represent the phonological asymmetry between voicing and aspiration languages.

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ⁱ A monovalent approach ([voice]/[Ø]) also exists.

ⁱⁱ An anonymous reviewer rightly points out that the scarcity of these systems is not so unexpected considering the combined effects of articulatory effort (prevoicing is more

difficult to produce than a plain voiceless plosive) and perceptual distance of fortis and lenis plosives.

ⁱⁱⁱ The following VOT values are reported:

Dutch (Lisker & Abramson 1964)					Low German (Braun 1996, citing Fischer-Jørgensen 1976)				
/b/	/d/	/p/	/t/	/k/	/b/	/d/	/p/	/t/	/k/
-85	-80	10	15	25	15	17	58	58	67

German values are averaged over three recording locations.

^{iv} I am very grateful to the Forschungszentrum Deutscher Sprachatlas and Regionalsprache.de (Philipps-Universität Marburg) for kindly making their data available to me.

^v Some Frisian locations are included. Frisian differs from Low Saxon, but as I am interested in the voicing continuum, and no political or geographical boundaries prohibiting a continuum exist, this is not considered problematic.

^{vi} Shapiro-Wilk test for normality ($W = 0.97362$, $p = 0.03568$).

^{vii} Here too negative VOT values influence lenis averages more than short-lag VOT values.

^{viii} Although there might be a few exceptions to this statement, the general trend is clear.

^{ix} An anonymous reviewer points out that speakers in the transition zone might have different grammars; i.e. one speaker might have a voicing system while the other has an aspiration system. This seems unlikely, however, considering the number of fully voiced clusters with a fortis C2, which are unexpected in both systems.