
# LINGUISTICA LETTICA

LATVIEŠU VALODAS INSTITŪTA ŽURNĀLS
2018 RĪGA 26

**Dibinātājs / Founder**
LU Latviešu valodas institūts

**Iznāk kopš 1997. gada / Published since 1997**



**Mājaslapa / Website**
www.lulavi.lv/zurnals-linguistica-lettica

**Indeksācija / Indexing**
Index Copernicus, ERIH PLUS

**Literārie redaktori / Proof-readers**
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ISSN 1407-1932

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**Rasmus PUGGAARD**

# REALIZATIONS OF /t/ IN JUTLANDIC DIALECTS OF DANISH

*Abstract*

Danish /t/ is an aspirated alveolar stop, and it is a well-known fact that the aspiration is typically realized as affrication in Standard Danish (e.g. Basbøll 2005: 60). An overt feature of the traditional dialect of Northern Jutland is the tendency to use a phonetic variant of /t/ sometimes called the 'dry /t/', realized with noiseless aspiration instead of affrication. 'Dry /t/' is typically realized with a dental place of articulation, and a significantly shorter Voice Onset Time (VOT) than Standard Danish /t/. In this paper, it is proven that 'dry /t/' – or at least a lower degree of noisy affrication and a shorter VOT than in Standard Danish – is found to some extent in all the major traditional dialect areas of the Jutland peninsula. Systematic variation in /t/ realization from dialect area to dialect area was also observed, in spite of the peninsula being a relatively small geographic area.

The study furthermore found an interesting association between the degree of frication, VOT, and the dialect area. Fully affricated /t/ was practically never found in Northern Jutlandic, and in the Southern dialect, dry /t/ was found only with a short VOT in unstressed syllables, with affricated or highly noisy /t/ otherwise being the norm. In short, there is a continuum of interplay between VOT and affrication in /t/ realization, so that in Northern Jutland even low levels of noisy aspiration are associated with a high VOT, while in Southern Jutland even affrication proper is not associated with a high VOT.

**Keywords**: Danish, dialectology, phonetics, variation, Voice Onset Time

# Līdzskaņa /t/ realizācijas dāņu valodas jitlandiešu dialektos

*Kopsavilkums*

Dāņu /t/ ir aspirēts alveolārs slēdzenis, un ir labi zināms, ka dāņu standartvalodā aspirācija parasti tiek realizēta kā afrikācija (sk., piemēram, Basbøll 2005: 60). Ziemeļjitlandes tradicionālā dialekta tipiskā iezīme ir tendence izmantot /t/ fonētisko variantu, ko dažkārt mēdz dēvēt par „sauso /t/" un kas tiek realizēts ar beztrokšņa aspirāciju, nevis afrikāciju. „Sausais /t/" parasti tiek izrunāts ar dentālu artikulācijas vietu un ievērojami īsāku balsīguma sākuma laiku (VOT) nekā dāņu standartvalodas /t/. Šajā pētījumā ir novērots, ka „sausais /t/" – vai vismaz mazāk izteikta afrikācija un īsāks balsīguma sākuma laiks nekā dāņu standartvalodā – vairāk vai mazāk ir atrodams visās galvenajās Jitlandes pussalas tradicionālā dialekta zonās. Pētījumā konstatēta arī sistēmiska /t/ realizāciju variēšana atkarībā no dialekta zonas, neraugoties uz pussalas nelielo platību.

Pētījumā tika novērota arī interesanta saistība starp afrikācijas pakāpi, balsīguma sākuma laiku un dialekta zonu: /t/ ar pilnīgu afrikāciju praktiski netika konstatēts ziemeļjitlandiešu dialektā, savukārt dienvidjitlandiešu dialektā „sausais /t/" ir sastopams tikai ar īsu balsīguma sākuma laiku neuzsvērtās zilbēs, bet citādi /t/ tiek izrunāts ar afrikāciju vai lielu trokšņa apjomu. Kopumā /t/ izrunā ir novērota pastāvīga saistība starp balsīguma sākuma laiku un afrikāciju: Ziemeļjitlandē pat zemas pakāpes aspirācija ar troksni saistās ar garu balsīguma sākuma laiku, savukārt Dienvidjitlandē pat izteikta afrikācija nav saistīta ar garu balsīguma sākuma laiku.

**Atslēgvārdi**: dāņu valoda, dialektoloģija, fonētika, variēšana, balsīguma sākuma laiks

## 1. Introduction

An overt feature of the traditional dialect of Northern Jutland, Denmark, is the tendency to use a phonetic variant of /t/ which is sometimes called the 'dry /t/'. What is meant by 'dry' is that although the variant is aspirated, the aspiration is neither noisy nor has affricated realization, as is the case for Standard Danish. A quick auditory inspection of some recordings of other Jutlandic dialects gave me the impression that this feature of noiseless aspiration may not be as

unique to Northern Jutlandic as it is typically thought. Using recordings from the corpus of the Peter Skautrup Centre for Jutlandic Dialect Research, this study tests whether affrication is a feature of /t/ in the different traditional Jutlandic dialects. It is found that while 'dry /t/' is particularly common to Northern Jutlandic dialects, it is observed to some extent in all traditional dialects of the Jutlandic peninsula. Furthermore, it is found that Voice Onset Time and affrication interact in interesting ways in the different dialects.

The structure of the paper is as follows: Section 2 gives a brief overview of the dialect situation, and introduces the existing literature on the realization of /t/ in Northern Jutlandic. Section 3 provides the methodology of the paper, including an introduction to the corpus of Jutlandic dialect recordings, the procedure for choosing tokens, and the measurement techniques. Section 4 provides the results of a series of statistical tests along with comments on these, while Section 5 discusses the results and provides ideas for further research, as well as some concluding remarks.

## 2. The Danish dialects and the 'dry /t/'

This section will provide a brief overview of the dialect situation in Denmark, as well as the existing literature on the 'dry /t/' variant.

### 2.1. The Danish dialects

Before the 1960s, the Danish speech community overwhelmingly consisted of dialect speakers (e.g. Kristiansen 2003a: 68). Traditionally, the Danish language has been divided into three major dialect groups: Eastern Danish, spoken on the island of Bornholm and the Southern part of what is today Sweden; Insular Danish, spoken on the islands of Zealand and Funen, as well as on smaller islands east of Jutland; and Western Danish, spoken in Jutland. Since the 16th century, Insular Danish started emerging as a spoken standard dialect (Kristiansen 2003b). The spread of this spoken standard dialect first accelerated in the early 19th century, when agrarian reforms resulted in increased mobility and an obligatory educational system was introduced with Standard Danish (i.e. High Copenhagen, cf. Kristiansen 2003b) as the medium of instruction (Pedersen

2003). In the period from the late 19th century until the 1960s, much of the dialect-specific vocabulary in the dialects of Jutland was substituted with Standard Danish vocabulary, along with some phonetic changes. By the 1960s, the dialects were largely moribund in the sense that they were no longer passed onto children (Kristiansen 1998: 116; 2003b: 87). The 1960s were a significant time for dialect leveling in Denmark, as Standard Danish as a common language became a central part of the government policy on mother-tongue education (Kristiansen 1990: 217ff; 2003a: 62), and as national broadcasting reached more public domains along with the spread of the private television set (Kristiansen 2003b: 87). The Danish Language Council was yet another major player in the development of standardization (Kristiansen 2003a; cf. Hansen 1991).

A consequence of the leveling of the Danish dialects is that now most of the recordings of spoken dialects are legacy data. Given that transmission of the traditional dialects had largely ceased by the 1960s, authentic data should be recordings of speakers who attended school before that time, although this does not ensure that they are dialect speakers. Luckily, a large corpus of authentic legacy data of Jutlandic dialects already exists; see Section 3.1.

## 2.2. The dry /t/

The dry /t/ is only rarely mentioned in academic literature, but it appears to be an overt feature of at least Northern Jutlandic dialects, in that it is a feature which laymen are typically able to associate with Northern Jutlandic. In one major Danish encyclopedia, an article on aspirates states that "Danish aspirates are e.g. the sounds *p* and *k* in Standard Danish and the 'dry' *t* that occurs in certain Jutlandic, particularly Northern Jutlandic, dialects" (Petersen 2009a, translation mine). The corresponding article on affricates states that "(…) the Danish *t* in Copenhagen pronunciation of e.g. *Tivoli* must be described as an affricate" (Petersen 2009b, translation mine).

Nielsen (1984: 149) describes the /t/ in Vendsyssel (the northernmost part of Jutland) as being characterized by a fronted pronunciation when compared to /t/ in other variants of Danish. He also writes that the aspiration of Vendsyssel /t/ is relatively weak. Espegaard (1996: 262) describes the /t/ in Hanstholm (in North-western Jutland) as being

pronounced behind the alveolar ridge, but otherwise makes no mention of its articulation. Typically, treatments of various Northern Jutlandic dialects (e.g. Jensen 1902; Nielsen 1959; Espegaard 1996) often neglect to mention that their pronunciation of /t/ differs from that of Standard Danish. As Jensen (1902: 89) simply notes of /t/ in onset position: "*t* corresponds to Standard Danish *t*." 'Dry /t/' has not been described for other Jutlandic dialects than Northern. On a curious side note, Grønnum (2005: 51) equates the purely aspirated /t/ with a 'high and formal style' (translation mine), a description which is not found anywhere else.

Descriptions of the phonology of Standard Danish, however, consistently mention that /t/ aspiration is realized as affrication, giving [tˢ] or narrowly [t̥͡s] (e.g. Basbøll 2005: 60).

The motivation for looking at other Jutlandic dialects, rather than just the Northern ones, came from a quick auditory inspection of online dialect sources. It showed that 'dry /t/' was not restricted to Northern Jutlandic dialects, though it appeared to be most prevalent there. This variant is presumably also best preserved in Northern Jutland today. The quick auditory inspection indicated that 'dry /t/' was not just a feature of Northern Jutlandic pronunciation, but a part of a continuum from non-noisy aspiration to affrication in /t/ pronunciation.

## 3. Methodology

This section will explain the methodological choices behind the paper. In the first subsection, the recordings used for the experiment and the corpus they are taken from will be presented and discussed. The next two subsections will delimit the sounds included as data points, and explain what they were coded for, how they were coded, and the theoretical background behind these choices.

### 3.1. Recordings

The recordings used for this study are from the impressive collection of the Peter Skautrup Centre for Jutlandic Dialect Research. The first recordings in the collection are from the 1930s and the latest from the mid-1990s, with almost 800 recordings from the first half of the 1970s alone (Andersen 1981). Most informants were born in the late 19th to the early

20th century. The recordings mostly consist of sociolinguistic interviews covering agricultural methods and living habits in the early 20th century, aiming to elicit dialect-specific terms. As it happens, this format is beneficial to this study as well, as Hay and Foulkes (2016) recently found that speech about older events tends to elicit older phonetic variants. The aim of the collection is to compile an extensive dictionary of terms used in the Jutlandic dialects (Rasmussen 2002; Hansen 2008).

While the collection is digitized and publicly available, the bulk of the recordings have not been transcribed. The data were originally recorded on tape, later preserved on CD, and are currently stored digitally as MPEG-1 files at a sampling rate of 44,100 Hz. MPEG-1 files are small and very practical to store, but it is a lossy format, meaning that some of the fine-grained details of the sound file may be lost in the conversion process, making them potentially problematic to use for phonetics studies (Bounds et al. 2011: 49). Nevertheless, the wealth of the corpus and what it can teach us about the Danish dialects should not be underestimated, and particularly the newer recordings can still be of use when researching certain phonetic phenomena.

In spite of the size of the corpus, the recordings chosen for this study are for several reasons a convenience sample. The collection is organized according to Denmark's old administrative division into parishes, hundreds, and counties, which was admonished in the 1970s. In this division, there were 24 parishes, around 150 hundreds, and more than 2,000 counties. Assuming only minor dialect differences within the hundreds, six hundreds were chosen to represent six dialect areas. For each of these hundreds, three speakers from different parishes were chosen. This number was based on the availability of decent quality data; it was judged that the recordings made before the mid-1970s were unfit for acoustic analysis, so these were excluded. Whenever possible, recordings from the 1990s were used.

This means that there are some limitations to the controllability of the data. It would have been preferable if all recordings had been carried out by the same researcher using the same equipment; if the gender distribution had either been more equal or if only recordings of males had been used (as women are known to use prestige forms more than men; see e.g. Trudgill 1972); if the sample had been bigger, etc.

Information about the recordings used can be seen in Table 1, which gives the location of the individual recordings (parish and hundred), the gender of the informants, their year of birth, and the year of recording.

*Table 1.* Information about recordings

| Parish | Hundred | Gender | Birth | Recording |
|---|---|---|---|---|
| 1251 Vrensted | Børglum/N | Male | 1889 | 1983 |
| 1252 Tise | Børglum/N | Male | 1903 | 1982 |
| 1255 Vrå | Børglum/N | Male | N/A | 1991 |
| 1373 Hørsted | Hassing/NW | Female | 1913 | 1991 |
| 1375 Stagstrup | Hassing/NW | Male | 1902 | 1975 |
| 1376 Skyum | Hassing/NW | Male | 1908 | 1994 |
| 1711 Vesterbølle | Rinds/NE | Female | 1908 | 1983 |
| 1713 Gedsted | Rinds/NE | Female | 1907 | 1983 |
| 1714 Fjeldsø | Rinds/NE | Male | 1898 | 1979 |
| 2091 Sjelle | Framlev/CE | Female | 1896 | 1980 |
| 2092 Skørring | Framlev/CE | Male | 1898 | 1989 |
| 2097 Framlev | Framlev/CE | Male | 1905 | 1976 |
| 2512 Sønder Nissum[1] | Ulfborg/CW | Male | 1896 | 1984 |
| 2513 Staby | Ulfborg/CW | Female | 1910 | 1975 |
| 2514 Madum | Ulfborg/CW | Male | 1910 | 1975 |
| 2591 Varde | Vester Horne/S | Male | 1905 | 1974 |
| 2592 Janderup | Vester Horne/S | Male | 1906 | 1975 |
| 2599 Henne | Vester Horne/S | Male | 1902 | 1975 |

The informants will be referred to by their parish numbers below. As can be seen, these recordings were carried out between 1974–1994; generally, the newest possible recordings were used, as they were of the highest quality. The informants were born between 1889–1913, and

[1] The recording from 2512 is not a sociolinguistic interview, but a monologue.

were between 65–94 years old at the time of recording.[2] As it can also be seen, there is a somewhat skewed gender distribution among the informants, with no female representatives from Børglum and Vester Horne, while two of the three informants from Rinds are female. It will be discussed in Sections 4 and 5 how this might affect the results. For clarity and brevity, in the following sections the hundreds will be referred to by their location in Jutland: Børglum – North; Hassing – North West; Rinds – North East; Framlev – Central East; Ulfborg – Central West; Vester Horne – Southern. These correspond to Jutland's major dialect areas as distinguished by Sørensen (1991).[3]

## 3.2. Included tokens

For each recording, the first 20 instances of simple /t/ onsets were measured and coded, giving a total of 360 tokens. What is meant by 'simple onset' is that initial consonant clusters with /t/ onset were excluded in order to keep analytical problems to a minimum (cf. Foulkes et al. 2011: 63). Danish phonology allows initial /tr/ and /tj/ clusters (Basbøll 2005: 206), /r/ phonetically being a uvular approximant [ʁ] in onset position in Standard Danish (Grønnum 2005: 158). According to Grønnum (ibid: 323), Danish also allows clusters of /st str stj/, but /t/ is unaspirated in this position; Basbøll (2005: 206) considers these to be /sd sdr sdj/ phonologically. The /tr/ clusters are excluded because affrication is realized differently in the context of an approximant than in the context of vowels, and because measuring the onset of voicing is less straightforward for approximants than for vowels. A further complication with measuring /tr/ is that /r/ is traditionally realized as a retroflex fricative or tap in Northern Jutlandic dialects (Nielsen 1984: 152; Jensen 1902: 95), including in /tr/ clusters (Nielsen 1984: 156). The /tj/ clusters are excluded because they are typically realized as [tɕ], and the cluster is thus expected to be affricated for all speakers, albeit at an alveolopalatal place of articulation (Grønnum 2005: 148).

[2] Unfortunately, the year of birth of the speaker from 1255 is unknown.

[3] There are actually two major dialect areas in Southern Jutland, but only the northernmost one was included here, as dry /t/ is typically described as a Northern Jutlandic feature. However, further studies of the pronunciation of /t/ in Jutlandic dialects should include all major dialect areas.

Likewise, all instances of /t/ in coda position were excluded, as /t/ is typically not aspirated in this position in Danish (Grønnum 2005: 134), although Nielsen (1984: 150) claims that it is often aspirated in coda position in the Vendsyssel dialect of Northern Jutland. Even when it is released, however, it is challenging to measure the duration of VOT when no vowel follows. A few instances of voiced /t/ were found during rapid speech, and a few of these were even affricated; these were excluded as well.

### 3.3. Measurement

Using the software Praat (Boersma, Weenink 2016), each of the tokens were coded for their phonetic environment, VOT, and degree of affrication, as elaborated below:

*Environment*. Each of the tokens were coded for the backness, height, and roundedness of the following vowel. While Danish actually distinguishes up to seven degrees of vowel height (Grønnum 2000), only four were distinguished when coding the tokens;

*VOT*. The duration of VOT was coded for each of the tokens. Following Foulkes et al. (2011: 63), measurements started at the point of the stop release, or at the point of the final stop release if multiple were visible in the spectrogram (cf. Cho, Ladefoged 1999: 215). Following Cho and Ladefoged (ibid.), the onset of voicing was identified at the first complete vibration of the vocal folds whenever possible. However, in the few cases where the waveform was not sufficiently clear to use this method, the onset of voicing was identified at the onset of striations in the second formant of the following vowel, following Klatt (1975);

*Degree of affrication*. Each of the tokens were coded on a 4-level scale for degree of affrication. The levels are defined as follows:

1 Good exemplars of dry /t/ – there is no affrication following the stop release, and the aspiration following the stop release is not auditorily noisy. This form often has a dental place of articulation. Acoustically, it is defined by not having irregular noise in its burst, but typically having visible formants prior to the onset of voicing;

2 Low-pitched noisy aspiration – there is no affrication following the stop release, but the aspiration is somewhat noisy, though not in a

way that resembles alveolar affrication. Acoustically, it is defined by having some irregular noise in its burst, albeit not high-pitched, and often simultaneous with some degree of visible formants;

3 High-pitched noisy aspiration – there is no affrication following the stop release, but the aspiration is noisy, in a way that resembles affrication to some degree. Acoustically, it is defined by having high-pitched irregular noise in its burst, sometimes simultaneous with some degree of visible formants. Auditory inspection of these tokens reveal, however, that the burst does not consist of alveolar affrication proper, but of high-pitched 'hissing' aspiration resulting not from the tongue being in contact with the alveolar ridge, but with the tongue remaining in close proximity to it;

4 Good exemplars of affricated /t/ – there is alveolar affrication following the stop release. Acoustically, it is defined by having high-pitched irregular noise in its burst (typically higher than level 3 tokens), while auditory inspection typically clearly reveals that the high-pitched noise is a result of actual affrication. As described by Puggaard (2015, forthc.), even in good exemplars of affricated /t/, the frication proper is often followed by a shorter burst of aspiration; these were still coded as level 4.

These levels are reasonably clear-cut when acoustic and auditory inspections are combined, and when the audio quality is good. For some of the older recordings, however, the spectrograms are less clear due to inferior recording quality; in these cases, coding of these levels sometimes relies on auditory inspection to an extent that is not ideal. An intercoder reliability test showed that coding of levels 2–3 in particular was somewhat inconsistent when relying only on auditory inspection of the tokens. The 4-level scale has nevertheless been retained, as the majority of the tokens were of sufficient quality to be coded on both acoustic and auditory grounds.

## 4. Results

In this section, results will be presented of a number of statistical tests showing the association between frication level, VOT, dialect type, gender, phonetic environment, and individual speakers. Interest-

ing findings will be elaborated throughout. All statistical tests were done using software by the JASP Team (2016).

## 4.1. Frication level

A significant association was found between dialect type and frication level ($\chi^2$ (15) = 74.25, p<.001), with a large effect size ($\varphi_c$ = 0.262); see Table 2.

*Table 2.* Contingency table showing the association between dialect type and frication level

| | **Frication level** | | | | |
|---|---|---|---|---|---|
| **Dialect type** | **1** | **2** | **3** | **4** | **Total** |
| CE | 16 | 9 | 11 | 24 | 60 |
| CW | 7 | 10 | 19 | 24 | 60 |
| N | 36 | 11 | 9 | 4 | 60 |
| NE | 12 | 15 | 16 | 17 | 60 |
| NW | 12 | 21 | 17 | 10 | 60 |
| S | 10 | 8 | 14 | 28 | 60 |
| Total | 93 | 74 | 86 | 107 | 360 |

As can be seen from Table 2, good exemplars of dry /t/ (level 1) are much more prevalent among the Northern Jutlandic speakers than among speakers from other dialect areas (N=36,60 %). Likewise, good exemplars of affricated /t/ (level 4) are more prevalent among the Central (N=24,40 % for both groups) and Southern Jutlandic speakers (N=28,47 %) than among the other groups, and are rare among speakers of Northern Jutlandic (N=4,7 %). Dialect area is thus a good predictor for which frication level will be found in the speakers' pronunciation of /t/. However, a contingency table showing the association between the individual informants and frication level demonstrates that despite the above results, frication level is to some degree idiosyncratic; see Table 3, where the Informant column gives the parish number, dialect area, and gender of the individual speakers.

*Table 3.* Contingency table showing the association between individual informants and frication level

| | Frication level | | | | |
|---|---|---|---|---|---|
| **Informant** | **1** | **2** | **3** | **4** | **Total** |
| 1251/N/M | 9 | 5 | 5 | 1 | 20 |
| 1252/N/M | 12 | 5 | 2 | 1 | 20 |
| 1255/N/M | 15 | 1 | 2 | 2 | 20 |
| 1373/NW/F | 4 | 7 | 7 | 2 | 20 |
| 1375/NW/M | 6 | 9 | 3 | 2 | 20 |
| 1376/NW/M | 2 | 5 | 7 | 6 | 20 |
| 1711/NE/F | 2 | 3 | 7 | 8 | 20 |
| 1713/NE/F | 1 | 7 | 5 | 7 | 20 |
| 1714/NE/M | 9 | 5 | 4 | 2 | 20 |
| 2091/CE/F | 3 | 0 | 4 | 13 | 20 |
| 2092/CE/M | 11 | 6 | 2 | 1 | 20 |
| 2097/CE/M | 2 | 3 | 5 | 10 | 20 |
| 2512/CW/M | 2 | 5 | 7 | 6 | 20 |
| 2513/CW/F | 1 | 0 | 6 | 13 | 20 |
| 2514/CW/M | 4 | 5 | 6 | 5 | 20 |
| 2591/S/M | 7 | 5 | 4 | 4 | 20 |
| 2592/S/M | 3 | 1 | 5 | 11 | 20 |
| 2599/S/M | 0 | 2 | 5 | 13 | 20 |
| Total | 93 | 74 | 86 | 107 | 360 |

This association is also significant ($\chi^2$ (51) = 156.9, p<.001), with an even larger effect size ($\varphi_c$ = 0.381). As can be seen from Table 3, there is significant variation in pronunciation within the dialect areas. Within the Northern group, for example, 1255 almost exclusively uses dry /t/, while 1251 uses them in less than half of /t/ tokens; in the Central Eastern group, 2092 uses dry /t/ much more than the other informants within the group; in the Central Western group, 2513 uses affricated /t/s much more than the other informants; and in

the Southern group, 2591 uses dry /t/s much more and affricated /t/s much less than the other informants. Another finding from Table 3 is that /t/ is not restricted to one realization type for any informant; in fact, all variants are found at least once for most informants, and there are several clear cases of speakers using different realization types in free variation.

A significant association was also found between gender and frication level ($\chi^2$ (3) = 22.37, p<.001) with a large effect size ($\varphi_c$ = 0.249); see Table 4.

*Table 4.* Contingency table showing the association between gender and frication level

| | **Frication level** | | | | |
|---|---|---|---|---|---|
| **Gender** | **1** | **2** | **3** | **4** | **Total** |
| F | 11 | 17 | 29 | 43 | 100 |
| M | 82 | 57 | 57 | 64 | 260 |
| Total | 93 | 74 | 86 | 107 | 360 |

These results have to be taken with a grain of salt, considering that all of the informants from the Northern Group are male. If we look again at Table 3, however, at least some of the individual variation can be explained by the gender of the informants. There is a rough tendency for female speakers to use affricated /t/ more than male speakers from the same dialect area, and for male speakers to use dry /t/ more. This tendency can explain why 2513, a female informant, uses affricated /t/ much more than the other Central Western informants, and why 1714, a male informant, uses dry /t/ much more than the other North Eastern informants. It cannot, however, explain any of the idiosyncrasy among the Northern and Southern informants, where all informants are male.

In brief, while the results in Table 4 may be somewhat exaggerated by the fact that all of the informants from e.g. Northern Jutland are male, they still appear to have some merit, in that they can explain some of the idiosyncratic variation seen in Table 3.

Summing up, we can say that there is a significant association between the dialect area of a speaker and their realization of /t/. There is, however, significant individual variation among the informants, some of which can be explained by a tendency for male speakers to use dry /t/ more than female speakers, and likewise, a tendency for female speakers to use affricated /t/ more than male speakers.[4]

## 4.2. VOT

A significant association was found between frication level and VOT, with $F(3) = 54.86$, $p<.001$ and a large effect size ($\eta^2 = 0.316$); see Tables 5 and 6.

*Table 5.* ANOVA summary showing association between VOT and frication level

| Factor | Sum of Squares | df | Mean Square | F | p | $\eta^2$ |
|---|---|---|---|---|---|---|
| Frication | 52575 | 3 | 17525.0 | 54.86 | < .001 | 0.316 |
| Residual | 113723 | 356 | 319.4 | | | |

*Note*. Type III Sum of Squares

*Table 6.* Descriptives, VOT × Frication level

| Frication | Mean VOT | SD | N |
|---|---|---|---|
| 1 | 34.73 | 13.07 | 93 |
| 2 | 46.28 | 16.86 | 74 |
| 3 | 57.67 | 17.59 | 86 |
| 4 | 65.56 | 21.93 | 107 |

As can be seen from Table 6, there is a strong tendency for tokens with high frication levels to also have high VOTs, albeit with some overlap between the different frication levels.

[4] This is not claimed to be a general tendency. The data behind Puggaard (2015, forthcoming) actually show a tendency for male speakers to have more affricated /t/s than female speakers among younger speakers of Standard Danish.

The level 1 tokens in particular have a strong tendency to be shorter than other levels; this is to be expected, as a longer release will typically lead to at least some degree of noisy aspiration. There is significantly more overlap in VOT between levels 3 and 4. This strong association appears to indicate that the associations between VOT and the various other factors would match the associations between frication level and the respective other factors. However, looking at the interaction between frication level and other factors reveals that the reality is not quite so simple.

As can be seen from Table 7, there are significant associations between VOT and both frication level ($F(3) = 44.45$, $p<.001$) and dialect type ($F(5) = 14.45$, $p<.001$), both with reasonably high effect sizes ($\eta^2 = 0.228$ and 0.123, respectively). A significant association is also found between VOT and the interaction of Frication × Dialect ($F(15) = 2.91$, $p<.001$), though only with a medium-sized effect ($\eta^2 = 0.075$). A closer look at Table 8 reveals an intriguing interaction between the three variables:

*Table 7.* ANOVA summary showing association between VOT, frication level, and dialect type

| Factor | Sum of Squares | df | Mean Square | F | p | $\eta^2$ |
|---|---|---|---|---|---|---|
| Frication | 31672 | 3 | 10557.4 | 44.445 | < .001 | 0.228 |
| Dialect | 17158 | 5 | 3431.5 | 14.446 | < .001 | 0.123 |
| Frication × Dialect | 10358 | 15 | 690.5 | 2.907 | < .001 | 0.075 |
| Residual | 79813 | 336 | 237.5 | | | |

*Note.* Type III Sum of Squares

*Table 8.* Descriptives, VOT × Frication level × Dialect type

| Dialect | Frication | Mean | SD | N |
|---|---|---|---|---|
| CE | 1 | 39.38 | 12.764 | 16 |
| | 2 | 59.44 | 20.983 | 9 |
| | 3 | 68.18 | 12.898 | 11 |

| | | | | |
|---|---|---|---|---|
| | 4 | 76.25 | 13.693 | 24 |
| | Total | 62.42 | 20.78 | 60 |
| CW | 1 | 40.71 | 12.051 | 7 |
| | 2 | 48.50 | 12.259 | 10 |
| | 3 | 56.84 | 11.692 | 19 |
| | 4 | 65.21 | 12.552 | 24 |
| | Total | 56.92 | 14.56 | 60 |
| N | 1 | 29.03 | 11.639 | 36 |
| | 2 | 52.27 | 10.808 | 11 |
| | 3 | 66.67 | 23.049 | 9 |
| | 4 | 48.75 | 7.500 | 4 |
| | Total | 40.25 | 19.75 | 60 |
| NE | 1 | 44.58 | 14.687 | 12 |
| | 2 | 49.67 | 15.864 | 15 |
| | 3 | 63.13 | 14.818 | 16 |
| | 4 | 87.06 | 22.504 | 17 |
| | Total | 62.83 | 23.96 | 60 |
| NW | 1 | 31.25 | 9.077 | 12 |
| | 2 | 37.38 | 15.781 | 21 |
| | 3 | 54.12 | 22.096 | 17 |
| | 4 | 60.00 | 18.105 | 10 |
| | Total | 44.67 | 20.08 | 60 |
| S | 1 | 36.00 | 11.972 | 10 |
| | 2 | 37.50 | 15.811 | 8 |
| | 3 | 42.86 | 9.139 | 14 |
| | 4 | 48.04 | 20.337 | 28 |
| | Total | 43.42 | 16.84 | 60 |

Given the strong association between VOT and frication level and the results presented in the previous section, one would expect speakers

of Northern Jutlandic to have very low average VOTs, and speakers of Southern Jutlandic to have very high average VOTs. This expectation does not match the results: as expected, speakers of Northern Jutlandic have low average VOTs, but speakers of Southern Jutlandic also do, while the higher average VOTs belong to speakers of Eastern dialects. It is the case within all dialect groups that a higher VOT correlates with a higher frication level[5], but the VOT values associated with the different frication levels vary a lot across dialects.

For speakers of Northern Jutlandic, level 1 frication correlates with a very low average VOT of 29 ms, while level 2 frication correlates with a much higher average VOT of 52 ms. Level 3 affrication correlates with a yet higher VOT of 67 ms, but this correlation is much less stable, with a high degree of deviation. There are too few tokens with level 4 frication to conclude anything on the basis of them. In brief, most tokens are short and have no noisy aspiration, and when they have somewhat noisy aspiration, they tend to be much longer.

For speakers of North-western Jutlandic, levels 1 and 2 both correlate with a low average VOT (31 ms and 37 ms). Levels 3 and 4 then correlate with higher average VOT values of 54 ms and 60 ms respectively. In this dialect, short tokens can and often do have noisy aspiration, while high-pitched noisy aspiration and frication tend to occur on longer tokens.

For speakers of North-eastern Jutlandic, levels 1 and 2 both correlate with semi-low average VOT values of 45 ms and 50 ms, respectively. Level 3 correlates with a high VOT of 63 ms, and level 4 correlates with a very high VOT of 87 ms. The same general pattern is found as in North-western Jutlandic, but with higher average VOTs all around, and with a stronger correlation between affrication proper and very long tokens; possibly because two-thirds of the North-eastern Jutlandic informants are female.

For speakers of Central Western Jutlandic, there are evenly spaced average jumps in VOT between the different frication levels, with level 1 lasting 41 ms and level 4 65 ms. There is thus a very strong

[5] With the exception of the N group, where level 4 has a strikingly low mean VOT. There are, however, so few examples of level 4 in the N group that this is not considered significant.

correlation between VOT and frication level in this dialect, with most tokens being of the long and noisy or affricated type.

For speakers of Central Eastern Jutlandic, level 1 frication correlates with a low average VOT of 40 ms, while levels 2–4 frication correlates with evenly spaced high average VOTs of 59 ms to 76 ms. In this dialect, short tokens with no noisy aspiration are relatively frequent, but most frequent are long tokens with affrication proper or high-pitched noisy aspiration.

For speakers of Southern Jutlandic, levels 1 and 2 both correlate with short average VOTs of 36 ms and 38 ms respectively, i.e. with no relevant difference. Level 3 correlates with a slightly longer average VOT of 43 ms, and level 4 with an average VOT of 48 ms. There is thus a very short gap in average VOT from level 1 to level 4, and the high deviation of VOT in level 4 tokens shows that even affricated tokens are not necessarily long in this dialect.

It is worth noting that the average VOT values for each dialect area fall well below numbers reported by Mortensen and Tøndering (2013) for spontaneous Standard Danish. They report an average VOT between 81.6–88.7 ms for simple onset /t/ depending on the height of the following vowel, while every single speaker measured for this paper has an average VOT of /t/ below 80 ms. This is a further indication that pronunciation of /t/ varies significantly from Standard Danish not just in Northern Jutlandic, but in all Jutlandic dialects measured for this paper.[6]

It should of course be noted that the sample size is rather small, and that the average VOT values might look different if based on a larger sample size. The patterns discussed above, however, fall in line with expectations: it makes good sense that noiseless aspiration is replaced by noisy aspiration or affrication if prolonged. Following this, it also makes good sense that in Southern Jutlandic, where the affricated realization is most frequent, it does not have to accompany an exceptionally long token – and that in Northern Jutlandic, where noiseless aspirated realization is most frequent, even slightly noisy aspiration would be a result of a comparatively very long token.

[6] Another possible explanation is that VOT of /t/ has generally increased in Danish.

As with frication type, an ANOVA testing the association between VOT, frication, and the individual informants found that much of the variance in VOT can be explained with idiosyncratic differences in pronunciation ($F(17) = 6.267$, $p<.001$) with a high effect size ($\eta^2 = 0.223$); see Table 9. It is also obvious from Table 10 that there is no linear relationship between an individual informant's average VOT and their dialect type. There is, however, no significant association between VOT and the interaction between Informant × Frication ($F(48) = 1.286$, $p=.11$), indicating that while individual speech habit is a good explanation of variance in VOT, it cannot explain the areal associations between VOT and frication level discussed above.

*Table 9.* ANOVA summary showing association between VOT, frication level, and individual informant

| **Factor** | **Sum of Squares** | **df** | **Mean Square** | **F** | **p** | **$\eta^2$** |
|---|---|---|---|---|---|---|
| Informant | 21447 | 17 | 1261.6 | 6.267 | < .001 | 0.223 |
| Frication | 3877 | 3 | 1292.5 | 6.420 | < .001 | 0.040 |
| Informant × Frication | 12428 | 48 | 258.9 | 1.286 | 0.110 | 0.129 |
| Residual | 58582 | 291 | 201.3 | | | |

*Note.* Type III Sum of Squares

*Table 10.* Descriptives, VOT × Individual informant

| **Informant** | **Mean** | **SD** | **N** |
|---|---|---|---|
| 1251/N/M | 54.25 | 21.292 | 20 |
| 1252/N/M | 34.25 | 16.880 | 20 |
| 1255/N/M | 32.25 | 12.719 | 20 |
| 1373/NW/F | 40.75 | 17.568 | 20 |
| 1375/NW/M | 32.75 | 14.643 | 20 |
| 1376/NW/M | 60.50 | 17.313 | 20 |
| 1711/NE/F | 72.75 | 27.790 | 20 |

| | | | |
|---|---|---|---|
| 1713/NE/F | 57.00 | 21.969 | 20 |
| 1714/NE/M | 58.75 | 19.254 | 20 |
| 2091/CE/F | 63.75 | 14.679 | 20 |
| 2092/CE/M | 45.25 | 14.643 | 20 |
| 2097/CE/M | 78.25 | 18.301 | 20 |
| 2512/CW/M | 60.50 | 11.227 | 20 |
| 2513/CW/F | 61.50 | 9.191 | 20 |
| 2514/CW/M | 48.75 | 18.487 | 20 |
| 2591/S/M | 42.50 | 14.734 | 20 |
| 2592/S/M | 50.25 | 22.093 | 20 |
| 2599/S/M | 37.50 | 9.389 | 20 |

While a significant association was also found between gender and VOT ($F(1) = 17.10$, $p<.001$), it has a somewhat poor effect size ($\eta^2 = 0.046$); see Table 11. While it is clear from Table 12 that female informants have higher average VOTs than men, it is also clear from Table 10 that the female informants do not have consistently higher VOTs than the male informants.

*Table 11.* ANOVA summary showing association between VOT and gender

| **Factors** | **Sum of Squares** | **df** | **Mean Square** | **F** | **p** | **$\eta^2$** |
|---|---|---|---|---|---|---|
| Gender | 7582 | 1 | 7582.2 | 17.10 | < .001 | 0.046 |
| Residual | 158715 | 358 | 443.3 | | | |

*Note.* Type III Sum of Squares

*Table 12.* Descriptives, VOT × Gender

| **Gender** | **Mean** | **SD** | **N** |
|---|---|---|---|
| F | 59.15 | 21.67 | 100 |
| M | 48.90 | 20.81 | 260 |

Summing up, a significant association was found between frication level and VOT. An interesting interplay was also found between frication level, VOT, and dialect area. The results do not show a continuum going from low VOT in Northern Jutland to high VOT in Southern Jutland. Rather, there was a continuum of interplay between VOT and frication levels, so that in Northern Jutland, even low levels of noisy aspiration were associated with high VOTs, while in Southern Jutland, even affrication proper was not associated with particularly high VOTs. This pattern cannot be explained with reference to idiosyncratic variation, but is clearly an effect of regional variation. A tendency was also found for female speakers to have longer VOTs than male speakers.

### 4.3. Effect of phonetic environment

As mentioned in Section 3.2., the data consists of the 20 first usable /t/ tokens of each recording. A result of this is that the following vowels are not evenly distributed, since they do not appear with /t/ equally frequently. This means that there is a vast majority of front vowels; a vast majority of unrounded vowels; and a vast majority of close and particularly close-mid vowels. The most frequent use of /t/ is, incidentally, as part of the function word /te/ 'to'. No significant association was found between backness or roundedness and VOT or frication type. Associations were found between vowel height and frication type. High vowels were found to be more likely to occur with levels 3–4 frication, which makes perfect physiological sense, and high vowels also correlated with higher VOTs, which was also found by Mortensen and Tøndering (2013). None of these effects appear to be regionally motivated, therefore they will not be dealt with further in this paper.

## 5. Discussion

The dispersion of dry /t/ to some extent throughout Jutland is a clear indication that /t/ realization differs from Standard Danish in traditional Jutlandic dialects. Another such indication is that the average VOT of the informants differed dramatically from the measurements

found by Mortensen and Tøndering (2013) for Standard Danish. This was particularly true for the Northern Jutlandic speakers, whose average VOTs for /t/ were closer to what Mortensen and Tøndering (ibid: 51) measured for /d/ in Standard Danish, but was ultimately true for every single speaker in the sample. Some of this variation can be explained by different delimitation techniques: Mortensen and Tøndering follow Klatt (1975) and Fischer-Jørgensen and Hutters (1981) in measuring the end of VOT at the start of higher vowel formants, instead of at the first complete vocal fold vibration, as done in this paper. They also limited themselves to stressed syllables. Both of these choices result in longer VOT measurements, but not nearly long enough to fully explain the difference in the results. A clear pattern such as the one found for affrication was not found for VOT; the average VOT for Southern Jutlandic speakers was almost as short as it was for Northern Jutlandic speakers.

While no systematic connection between dialect area and VOT was found, there was a systematic connection between dialect area and the interplay between VOT and /t/ affrication. In Northern Jutland, dry /t/s were short and regular, while more noisy /t/s were significantly longer on average. In Southern Jutland, even fully affricated /t/s were often comparatively short. Since /t/ realized with noisy aspiration or affrication is rather marked in Northern Jutlandic dialects, it tends to occur with marked (i.e., long) tokens; since it is less marked in Southern Jutlandic, it has less of a tendency to occur with marked tokens. These were not clearly delimited features, but rather ends of a continuum.

When selecting recordings to use for this study, the first priority was to get reasonable quality recordings of speakers from roughly the same area. Gender was considered a less important factor, which resulted in a skewed gender distribution. The results, however, show that female speakers have a higher tendency to produce /t/ with noisy aspiration or affrication, and that they have higher VOTs on average. The results would certainly have been clearer if the gender distribution had been equal, or at least similar for all the dialect areas.

Generally, a larger sample would have resulted in clearer results. There were considerable individual differences within the dialect areas; a problem which would not have been solved, but only possibly

exacerbated by including more tokens per speaker. The problem could potentially be solved by including more speakers per dialect area, which might level out some of the individual differences and give a clearer overall picture. Such a study could be implemented, but one would have to sample wider within the major dialect areas, as many of the hundreds (see Section 3.1.) cannot be expected to have more than three good quality recordings.

There are other measurable factors that might provide insights into the acoustics and dispersion of the different /t/ variants, such as speech rate, intensity, and centre of gravity. While speech rate of the informants could certainly be measured, the somewhat unstable circumstances of the recordings would make intensity measurements unreliable. Measuring centre of gravity is a reliable way of measuring degree of frication, and less prone to human error than the acoustic judgments done for this paper (e.g. Boersma, Hamann 2008), but many of the recordings of the sample are of insufficient quality to use this method. Particularly for the /t/ tokens without noisy aspiration, the background noise of the recordings might be measured instead of the actual aspiration.

The continual nature of the dispersion of the different variants means that it is poorly suited to be represented in a traditional isogloss. A more suitable visual representation of the dispersion would be a diffusion model such as the ones presented in Prokić and Cysouw (2013). Making such a model would demand a much larger sample, but the project should certainly not be abandoned for that reason. There is, after all, a huge amount of natural data available in the Peter Skautrup corpus, and a huge amount of work that has yet to be done with it.

## Conclusions

As expected, the results show that the variant known as dry /t/ is not exclusive to Northern Jutlandic dialects, but spreads to some extent through all the traditional Jutlandic dialects. A clear pattern emerged of dry /t/ being more frequent in the Northern regions of Jutland, and affricated /t/ being more frequent in Central and Southern

regions of Jutland: the further north, the less affricated /t/. The current sample was unable to show a significant difference between Eastern and Western Jutland, but such a difference should not be rejected yet.

## Acknowledgments

I would like to thank Anna Jespersen for her helpful comments on and guidance for a previous version of this paper, as well as the researchers at the Peter Skautrup Centre for Jutlandic Dialect Research for providing the data and sharing their knowledge, and Mads Lundegaard for his help in analyzing the recordings. I would also like to thank the two anonymous reviewers and the participants at the 4th CRIPAP conference in Rīga for their helpful comments.

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