# Bachelor Thesis

# A new language and a new sound?

## An Investigation of Phonetic First Language Attrition in Dutch due to Use of English

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Appendix

Praat scripts (Georg Lohfink)

# 1. Introduction

This study is an exploration of possible phonetic drift from first language norms (hereafter referred to as phonetic L1 attrition) as found in the accents of adolescent speakers of Dutch who live and study in an English environment. Previous research by Flege, Major and others has suggested that proficiency in and frequency of second language (L2) use can affect fluency in a speaker's first language (L1), and that phonetic category boundaries in the L1 may shift as a response to L2 acquisition. This is an investigation of a possible drift of phonetic categories in a person's L1 and L2 speech as part of a first language attrition process.

## 1.2 Background

A relatively large number of study programmes in the Netherlands are taught in English. In July 2014 there were 127 Dutch-English bilingual secondary schools (out of approximately 1320 in total) in the Netherlands, providing pupils with education in both their first language and English (according to the "Landelijk netwerk voor tweetalig onderwijs"). Utrecht University already teaches more than half of their master degrees in English. On the 14th of April 2015 it was reportedly set as a goal to have all masters programmes taught exclusively in English in the future, to prepare students for internationally oriented work on a global market (*Werkprogramma Internationalisering* by College van Bestuur Universiteit Utrecht). If, as previous research has suggested (Major, 1992), frequent use of a second language could spur L1 attrition (temporary or permanent loss of one's first language), then the total transformation of all masters programmes at universities to English might negatively affect Dutch speakers' fluency or intelligibility in their native language. This study will attempt to shed some light on the ways in which frequent use of English as a second language might affect native speakers of Dutch in segmental phonetic aspects of their accents.

Two features that have been reportedly problematic for Dutch speakers are correct degrees of aspiration for /p t k/ and a correct realisation of the phoneme /s/ in English (Collins & Mees, 2013: 217). If a Dutch speaker becomes more fluent in English and starts to acquire more native-sounding realisations of these phonemes, then this may affect the way these phonemes are realised in the speaker's Dutch, as will be explained hereafter. Therefore the objects of focus in this study will be the phoneme /s/ and Voice Onset Time (the time that elapses between the start of a burst and the start of a vowel) for /t/ and its voiced counterpart /d/. The present study will examine whether these features are also problematic, and whether or not they remain so, for monolingual speakers of Dutch from the LUCEA (Longitudinal Utrecht Corpus of English Accents) speech corpus compiled at University College Utrecht, an English language undergraduate college with an international student body.

### *1.2.1 First Language Attrition*

Previous studies have shown that L2 proficiency correlates with L1 loss (Major, 1992: 201), alternatively termed "L1 attrition". Language attrition is a process by which fluency and/or proficiency in a language is lost or impaired due to long-term disuse. The higher the original level of language training, the less language loss in that specific language occurs (De Groot, 2011: 347). Nonetheless, research suggests that an L1, like an L2, is also susceptible to loss or inaccessibility (De Groot, 2011: 353). It seems that the language one is exposed to and uses currently gradually replaces (or dominates in terms of fluency) a prior one when the latter is no longer used (De Groot, 2011: 347). Scientific studies have reported that people learning an L2 may have trouble retrieving words in their own language after speaking the L2 for a longer period of time, due to the suppression of L1 phonology during L2 use (Levy, 2007: 29). This continuous suppression of L1 phonology may have an effect on L1 accent in long-term intensive L2 use, in an environment such as the Anglophone undergraduate college University College Utrecht. If it is true, as some Dutch students at UCU have reported informally, that their speech starts showing non-native features due to their frequent use of English, then this may be regarded as "phonetic first language attrition".

Second language fluency is not necessarily the essential factor for L1 attrition, but the extent to which the second language is used does have a major impact. Studies of proficient second language (L2) learners have often noted phonetic drift of their native language (L1) with regards to monolingual norms (Chang, 2011: 428). Chang's own study (2011) on English adults taking elementary Korean classes showed that there was already a vowel shift in the L1 after only one week of classes and use of Korean. However, the shift in vowel dispersion was so slight it was not audible, and thus did not result in a `foreign accent´ as judged by other native speakers of English. He writes that in accordance with the view that "a L2 that is hardly mastered should not have much influence on L1, while a L2 which is mastered to a high degree should exert more influence", L1 phonetic drift in late L2 learners has only been documented in highly proficient L2 speakers" (Chang, 2011: 430). However, Chang points out that his findings suggest that L1 phonetic drift also occurs in the short term (2011: 428), even in adult learners. It is therefore possible that UCU students will show some phonetic drift after 3 years of studying at the college and being part of this English-language speech community.

The occurrence of language attrition does not depend merely on fluency or the extent to which a language is used. Other major influences are age, a person's identity or their own perception of their identity, and their attitude towards a particular language and the culture and experiences associated with it (Schmid, 2002; Schmid, 2004). The less one feels connected to the culture pertaining to a language, and the less one feels that that language is part of one's identity, the more attrition is likely to occur for that language. "Loss" of fluency in a language may not actually be permanent loss; it can also be a temporary inability to access the language. For Dutch students at UCU, the "loss" of fluency that many have informally reported (in terms of word retrieval and possible change in accent) may be temporary rather than permanent. It is likely that they will become more fluent once they stop using English to such a large extent and reintegrate into a Dutch-speaking community. This was the case in Schmid's study (2002) of German Jews in Anglophone countries; they had not lost their German permanently, and complete proficiency could be reactivated. Their attitude towards their native language, however, was very negative because of associations with the Nazis and the holocaust, which the majority of participants in the study had escaped by moving to the U.S.

Besides identity, the age at which an L2 was learned, or the age at which one stopped using one's L1 also has an influence on attrition. In Mayr et al.'s study (2012), a pair of Dutch-English late bilingual monozygotic twins was studied with regards to their Voice Onset Time productions. Participants TZ and MZ both lived in the Netherlands, but used English for job purposes on a daily basis. Participant MZ moved to the U.K. at age 32, while TZ remained in the Netherlands, but kept using English on a daily basis. They first learned English between the ages of 13 and 18; after what is normally considered the critical period (0-8) (Mayr et al., 2012). Interestingly, MZ produced VOT-values for Dutch word-initial voiceless plosives that are too long for native-sounding Dutch, but too short for those plosives native-sounding English. Such compromised VOT values are a common symptom of L1 attrition (Flege & Major as cited in Mayr et al., 2012). However, her prevoicing for voiced word-initial plosives showed an overshoot for both Dutch and English. Monophthongs and diphthongs in her Dutch were not erratic, but showed a more open realisation than the native Dutch norm. Overall, the shift in her L1 vowel space was a slight one towards her L2 (Mayr et al., 2012, p. 696). These results are consistent with Flege's (1995) claim that differences between L1 and L2 categories are more likely to be perceived in early than late bilinguals (Mayr et al., 2012, p. 698).

Many phonetics and phonology studies that rely on the phonemic theory framework[1] tend to regard L2 sounds produced by a language learner as "correct" or "incorrect" discrete entities, rather than variations on a continuum of approximations to phonetically accurate L2 sounds. This is probably due to the fact that human listeners tend to perceive sounds in any language as part of the phonetic categories from their L1 (Flege, 1980). According to Flege (1995), there is no critical period after which it is impossible to acquire an L2 sound system; the capacities with which the L1 sounds were learned remain in place and the L1 phonetic categories evolve over time as new sounds and languages are learned. Adult learners of a foreign language may modify pre-existing phonetic patterns, make slow progress in acquiring the phonetic norms of a target language, and adopt somewhat different phonetic strategies for producing new or phonetically different sounds in L2 (Flege, 1980).This would mean that even UCU students who do not identify as bilingual with English, but only started using English on a daily basis when coming to UCU, would be able to amend their L1 phonetic categories, and thus produce different L1 sounds under the influence of English.

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[1] Specification of speech sounds by means of binary distinctive features, ignoring slight acoustic differences that carry no linguistic significance (Flege, 1980: 119).

It was shown in Roy Major's(1992) study that in formal style speaking in L1, language attrition in the form of a foreign accent due to use of L2 is usually less prevalent than in informal style speaking (191). This is coherent with Labov's (1972) theory of formality in speaking settings, which says that in formal speech speakers will pay more attention to "correct" pronunciation than in informal speech, where they can speak more freely. This means that informal L1 speech will begin to show non-native features through L2 influence sooner than L1 formal speech. It is therefore unlikely that L1 formal speech will already show phonetic features of English after 3 years of time. One cannot be accepted to UCU unless one speaks English quite fluently (the college asks for a certain grade point average or qualification). Therefore, if L1 attrition occurs, it is possibly as a result of increased proficiency in the L2 in combination with frequent L2 usage, and perhaps a different attitude towards the L1 and L2 in relation to identity after being part of an L2 speech community for several years.

### *1.2.2 The linguistic environment of University College Utrecht*

All education at University College Utrecht is conducted in English; this means all classes are taught in English, papers, essays and other assignments are to be written in English, and officially, English is the lingua franca of the college. The international nature of this English language college provides an interesting environment for the study of accents. The UCU Accent Project has been compiling recordings of students' accents since 2010, to form a corpus of speech data referred to as the LUCEA corpus. Around 60% of the speakers in this database have Dutch as an L1, and there are speakers of 30 other L1s apart from English on the UCU campus. Around 25% of the approximate 700 students at UCU have their speech recorded for the LUCEA each year (Quené & Orr, 2014, p. 342). Every participant is recorded 5 times throughout their 3 years at UCU.

Most of the Dutch students of University College Utrecht still use Dutch very frequently outside classes with other students, or off-campus. The extent to which they do this varies per person. Many Dutch students informally report occasional problems with vocabulary retrieval or grammatical conjugations in Dutch, yet complete inability to access the L1 does not occur among Dutch UCU students. It is possible that the development of L1 accent for Dutch UCU students will be similar to that of the Dutch twins in Mayr et al.'s study (2012), who were classified as "late consecutive bilinguals, resident in an L2-speaking environment, who encounter changes in their L1 accent, often despite continued use of the L1" (687).

For some, studying at an English-language college while living in a Dutch-speaking country implies frequent code-switching between two languages (and perhaps even one or more other languages or dialects) every day. Frequent code-switching (alternation between two different languages, dialects, etc.) has been found to increase the likelihood of late consecutive bilinguals living in an L2-speaking environment being perceived as non-native in their L1 (Mennen et al.,2010: 35). The code-switching that happens due to the presence of texts in both the L1 and the L2 in the Accent Recordings which were used for this study are likely to have some effect on fluency and accent in both languages. When participants in a study think that both L1 and L2 will be relevant for the recording they will keep both activated. On the one hand, this keeps them more aware of their speech, whereas on the other hand it allows for more interference of L1 in L2 and vice versa (De Groot, 2011, p. 354). Therefore the students' speech might be under the influence of a "code-switching mindset" imposed on them by the nature of the Accent Recording as well as the frequent switching between different cognitive phonetic categories and phonetic settings in everyday interaction with fellow students.

Since UCU students do not receive any education with regards to "correct" pronunciation of English by the institution, there are no official pronunciation rules for either English or Dutch other than sociolinguistic ones created by the UCU community itself. Students' accents in English have been found to assimilate to each other in a single conversation as well as over time due to intensive contact (Quené& Orr, 2014: 345). It is likely that the same occurs for students' accents in Dutch. If any phonetic change in Dutch speakers' Dutch occurs, it does therefore not necessarily have to be a consequence of L1 attrition due to L2 usage, yet may also, or instead, be due to long-term phonetic accommodation processes at work in Dutch-language interactions on the UCU campus. Similarly, there may be large-scale (national) linguistic trends that also affect the way UCU students amend their accents.

### *1.2.3 Discriminating Between Dutch and English speech features*

As mentioned previously, aspiration for /p t k/ and a correct realisation of the phoneme /s/ in English are factors of difficulty for Dutch speakers (Collins & Mees, 2013: 217). The difficulty Dutch speakers have with these sounds may be due to global as well as local phonetic differences between Standard Dutch and English. There are considerable differences between Dutch and English vowel durations, for instance. In Dutch, duration is a significant cue for discriminating, for instance, the low vowels [ɑ]and [a:], although it is not the only one (there are also acoustic differences due to slightly different jaw positions) (Collins & Mees, 2013: 68). Phonetic studies suggest that the differences between short and long vowels in Dutch are also greater than those between analogous sounds in English (Dietrich et al., p. 16027). It seems to be vowel quality rather than duration that creates difficulties for native Dutch speakers. Rounded front vowels present in Dutch, such as /y/, are absent in English (Collins & Mees, 2013: 68). The differences in vowel space between the two languages might have some influence on the position of the tongue, the lips and the jaw in the realization of obstruents, such as stops and fricatives. This articulatory influence of the vowel on the realisation of an adjacent obstruent/consonant is termed "coarticulation" (Ladefoged, 1975: 48).

There are differences in the production of stops in Dutch and English too. English has voiced as well as voiceless final stops, because it retains the fortis-lenis (voiceless-voiced) contrast word-finally, whereas Dutch does not (Collins &Mees, 2013: 56). Many Dutch speakers do not voice final consonants that ought to be voiced in English, such as /d/ in 'bed', due to the phonotactic constraint that makes final voicing impossible in Dutch. In Dutch, there is devoicing of final [d] and [b] to respectively [t] and [p]. Final voicing, however, is quite common for word-final positions in Dutch when the onset of the next word is voiced (e.g.: *ik ben* [ɪgbɛn]); such fortis-lenis assimilations are not found in English (e.g.: *back door**/bæg ˈdɔ/ or *not bad**/nad ˈbæd/) (Collins & Mees, 2013: 126). This possibly has to do with the relatively large amount of prevoicing for Dutch initial plosives (in comparison with English) (Van Alphen, 2007) which allows for such anticipatory coarticulation (Ladefoged, 1975: 49).

*VOT*

Voice Onset Time, or VOT, is the time that elapses between the start of voicing relative to the release of a closure (Ladefoged, 1975: 124). Voice Onset Time can be positive in the form of aspiration; a sound is aspirated when there is a period of voicelessness during and after the release of a stop articulation, as in the aspirated /p/ in "pie" [pʰai] vs the unaspirated one in "spy" [spai]. While English is a language that has aspiration, Dutch belongs to the category of languages without aspiration (Collins & Mees, 2013: 88). Voice Onset Time for voiceless stops is frequently much longer in English than in Dutch due to this aspiration. VOT for voiced initial plosives, however, is often negative in Dutch, as a result of what is called "prevoicing" (the time taken up by voicing before the release of a stop) (Van Alphen, 2007). For instance, the prevoicing for the /d/ in the Dutch 'den' (/dɛn/; pine) usually takes longer than it would for /d/ in the English 'den' (/dɛn/).

VOT values have been shown to correlate with other aspects of phonological proficiency, including global foreign accent, or the degree of foreign accent an L2 learner exhibits, as judged by native speakers (Major, 1992: 190) and previous studies have shown differences and changes in VOT values in both L1 and L2 due to the acquisition of L2 fluency (Flege, 1987; Major, 1992). Therefore VOT seems to be a reliable indicator of a foreign accent, and of long-term accent change.

*The phoneme /s/*

The phoneme /s/ is a voiceless alveolar fricative characterised by a 'sharp hissing sound'. Both /s/ and its voiced counterpart /z/ are produced with two constrictions in the oral cavity. There is a seal between the edges of the tongue and the teeth, preventing the airstream from passing over the sides of the tongue. A second constriction is important for the production of these alveolar fricatives: a narrow opening between the upper and lower incisors. The voiceless fricative /ʃ/ is phonetically very similar, but is more (alveo)palatal (the constriction is made slightly further back), and the midline groove is shallower than for /s/ and /z/

(Raphael et al., 2007: 143). /s/ and /ʃ/ are both obstruents, meaning they both involve a continuant obstruction of airflow from the lungs (Ladefoged, 1975: 53). What distinguishes the two, however, is that /ʃ/ is often accompanied by lip rounding, while this is relatively rare for /s/ (Raphael et al., 2007: 143). A wide range of constriction larger than those for /s/ will result in /ʃ/- type sounds (Raphael et al., 2007:143).

Both /s/ and /ʃ/ are [+sibilant], meaning that they are characterised by a certain amount of high frequency energy (Ladefoged, 1975: 265). Some argue that there is only a difference in centre of gravity, the strongest frequency in Hz in a graphic representation of the length of the back cavity (the space in the mouth behind the constriction of the airflow, closest to the tongue root) during the production of a sound (Stevens, 2002: 279). A narrow band of high-frequency, high-energy noise characterises /s/ and /z/. Most of the sound energy for /s/ is above 4 kHz, whereas for /ʃ/ it is around 2,000 Hz and above for a male speaker. The more posterior place of articulation and the lip rounding and protrusion associated with /ʃ/ both lengthen the front cavity, resulting in lower frequency energy (Raphael et al., 2007: 145).

Techniques such as flesh-point tracking techniques and electropalatography have been used to demonstrate that it is possible to argue that a language has a specific "phonetic setting". This term encapsulates phonetic, articulatory and voice-quality settings of a specific language (Mennen et al, 2010). However, it must be noted that an articulatory setting never applies to every single segment a speaker utters (Mennen et al, 2010: 33). Moreover, there are differences in articulatory setting across different varieties of a language. There is a noticeable difference in articulatory setting for Netherlands Standard Dutch and Flemish Dutch, for instance (Collins & Mees, 2003: 221). Still, researchers have been investigating how the way in which specific sounds are articulated in a language might result in a certain tendency for phonetic setting of the spoken language as a whole. For instance, a tapered tongue setting with a small area of contact is used for alveolar consonants in English. There is a blunter tongue setting for alveolars in Standard Dutch(Algemeen Nederlands, or the contested term "Algemeen Beschaafd Nederlands"; "General Civilised Dutch"), where a larger portion of the tongue is used (Collins & Mees, 2013: 61). Moreover, English has been found to have a "more fronted tongue position" than Standard Dutch (Lowie & Bultena, 2007, as cited in Mennen et al, 2010). Dutch also has front rounded vowels, such as /y/ as in "duur", whereas English does not (Collins & Mees, 2013: 68). The fact that lip-rounding and a blunter and more palatal tongue-setting are more present in Dutch than in English could account for the higher degree of lip rounding that is used for /s/ in Dutch. Due to this more retracted tongue-setting and a larger degree of lip-rounding, the /s/ sound in Standard Dutch seems to contain, at least in informal observation, some /ʃ/ approximation. Collins & Mees (2003) state that his /ʃ/ approximation occurs mostly in clusters (such as: spin, stuur) and at the end of words (as in: was, dus, huis), or after /r/ (e.g.: kikkers) (190).

Van Heuven et al. (2005) suggest that acoustic characteristics of a sound need not always correspond with the perception of that spoken sound. They showed that the acoustic measurements of the diphthong /ɛi/ overestimated the perceived openness of this vowel when produced by male speakers. This implies that even if there are acoustic or articulatory changes in people's accents, these might not be audible for all, maybe not even for any, other speakers of the language. The relationship between articulatory settings and acoustics is also insufficiently understood, as yet, for acoustics to be seen as direct representations of articulatory settings and their acoustic effect (Mennen et al, 2010: 17). However, it has often been demonstrated that there is a causal relation between articulation and acoustic phenomena (Mennen et al, 2010: 26). This study therefore attempts to find measurable acoustic changes in terms of formants and formant frequencies, and will investigate neither articulatory change nor perceived accent change (by the speaker themselves or by other native speakers).

As Collins & Mees (2013) point out, "The looser lip setting and the relaxed tapered tongue shape of English alveolars seem to be one reason why fortis stops in English are frequently realized with aspiration" (p. 61). Therefore, one could argue that the difference between Dutch and English average VOT values and the realisation of the /s/ phoneme are both a result of differing overall lip and tongue settings. If frequent use of English will gradually install these different settings in Dutch speakers, this may result in accent change on the level of individual phonemes. Phonetic setting is learnable (Mennen et al., 2010: 35), and therefore it would seem that an existent phonetic setting can be altered over time.

### *1.2.4 Equivalence Qualification, Assimilation & Dissimilation*

Prince & Smolensky and Flege have created several theories related to long-term phonetic drift in an L1 and L2 as a response to acquisition and attrition processes.

*Optimality Theory*

Prince and Smolensky's Optimality Theory (1993) says that sounds in the L2 for which there is no similar counterpart in the L1 are often substituted by L2 speakers with a sound that is most like the target sound. This will explain why, for instance, many L1 Dutch speakers substitute the /æ/ in English with /ɛ/, as in /bɛ:t/ for 'bad'. In the same way, they might use their more palatal, lip-rounded /s/ as a substitute for the sharper alveolar English /s/.Another interesting example of this Optimality Theory in the case of obstruent sounds is the difference in the way Dutch and German native speakers produce the /ð/ and /θ/ in English when they are unable to produce these dental fricatives. The Germans and the Dutch differ in the way they choose the optimal approximation for /ð/; German speakers tend to choose a voiced fricative /z/, while the Dutch opt for a voiced stop, /d/ (Collins &Mees, 2013: 215). The Germans thus choose manner of articulation as the criterion for optimal approximation, whereas the Dutch choose place of articulation. Such differences can potentially tell us about processes of phonetic category formation in Dutch and German native speakers.

*Equivalence qualification & assimilation*

Flege claims that failure to distinguish between similar sounds in L1 and L2 is due to *equivalence classification* "a basic cognitive mechanism which permits humans to perceive constant categories in the face of inherent sensory variability found in the many physical exemplars which may instantiate a category" (Flege, 1987: 49). In the case of Dutch and English, Dutch speakers who are unable to perceive the difference between /æ/ and/ɛ/ may categorise them as the same, and subsequently develop their Dutch /ɛ/ towards a lower vowel /æ/. This equating of the L1 and L2 phoneme inhibits the establishment of a separate category for the L2 phoneme. Flege therefore believes that L2 sounds that are very similar to L1 sounds, thought not identical, are harder to acquire than L2 sounds that do not occur in the L1 (Flege, 1987).

Flege and his colleagues conducted a series of studies that all point towards the conclusion that the VOT value realised for the targeted language is influenced by the VOT value of the same consonant in the non-targeted language in bilinguals, thus producing VOTs in both languages that are not entirely native-like (De Groot, 2011: 363). Many L2 learners therefore have VOT-lengths that can be considered "intermediary"; they are in between a native L2 VOT-length and the L1 VOT-length. Only if a speaker can produce accurate VOT durations in a target L2 at any speaking rate, one can argue that they have established "correct" L2 phonetic categories (Zampini, 2008: 224). Ioup, amongst others, has suggested that people who learn an L2 before the age of 6 or 7 are more likely to produce native-like VOT durations, and that those who start learning the L2 later in life are likely to produce a compromise VOT (between L1 and L2 length) (Zampini, 2008: 223). Various studies have found compromises in bilinguals' L1 VOT-lengths too. These findings suggest that "L1 phonetic representations may be restructured in response to the acquisition of L2" (Zampini, 2008: 223). This would suggest that phonetic categories in an L1 may be amended, resulting in audible phonetic change in a speaker's accent.

*Dissimilation*

Studies conducted by Flege (1995, 2002) and others revealed that cross-linguistic interaction does not necessarily lead to assimilation of L1 and L2 categories, but may instead result in dissimilation. Flege and Eefting (1987), for instance, found that native-Spanish advanced learners of English produced Dutch /t/ with VOT values shorter and thus more dissimilar from English ones, than those produced by Spanish speakers with less English-language experience (81). According to Flege's Speech Learning Model (1995), this is to keep L1 and L2 phonetic categories as distinct as possible.

According to Flege's model, it is possible that people who have two distinct categories for the phoneme /s/ in English and the phoneme /s/ in Dutch will develop a more palatalised /ʃ/-like /s/ in Dutch and a sharper, alveolar /s/ in English, making the two distinct categories more extreme. On the other hand, people who do not distinguish between the two different /s/ phonemes cognitively will probably assimilate their Dutch and English /s/

over time, thus forming an intermediate form which they may use in both languages (Zampini, 2008: 223).

Similarly, UCU students who do not discriminate between Dutch and English VOTs are perhaps unaware of the difference. Those who, for instance, produce the /t/ in "tea" without aspiration are possibly not aware that this is a rule of English pronunciation; there is no aspiration in, for instance, the Dutch "thee". They will, according to Flege's theories, not form a new category of VOT values for syllable-initial dental plosives in English. They will thus unconsciously merge Dutch and English VOT categories together once they start producing English word-initial plosives with some aspiration due to, for instance, phonetic accommodation to their peers. This might consequently cause them to produce intermediary VOT values for both the L1 and L2. Those speakers who do, however, perceive a difference between Dutch and English VOT (whether consciously or subconsciously) might start creating more phonetically distant categories for Dutch and English (Flege, 1995).

However, there are instances (although they are rare) of speakers who do not show any assimilation *or* dissimilation in their phonetic categories (Mayr et al., 2012).Studies by Major (1992), Mennen (2004) and others all had one participant who targeted phonemes or VOTs exactly right in both their L1 and L2, thereby producing entirely native-sounding features (Mayr et al., 2012, p. 689). Hereby it may be concluded that it is possible to become fluent in an L2 without exhibiting L1 attrition, and that the extent to which L1 attrition occurs can vary a lot across people.

### *1.2.5 Research Aim*

When a Dutch speaker becomes more fluent in L2 English and starts to acquire more native-like realisations of the 'problematic' phonemes /s/, /d/ and /t/, then this may affect the way these phonemes are realised in the speaker's L1. The aim of this study, therefore, is to investigate whether there are any changes in VOT durations for syllable-initial phonemes /d/ and /t/ and whether there is any acoustic change (in centre of gravity) for the phoneme /s/ in the L1 and L2 for Dutch speakers of English. A dataset of longitudinal recordings compiled over the course of 3 years of students' study and frequent and intensive L2 (English) usage at University College Utrecht will be used for these purposes.

# 2 Methodology

The data used for this research are all part of the 2nd cohort of recordings from the Longitudinal University College English Accents Corpus (LUCEA). This corpus of speech recordings has been compiled over the last 5 years (starting 2010) in the Accent Project at University College Utrecht. Participants are recorded in 5 sessions; in September of year 1, May of year 1, September of year 2, May of year 2, and May of year 3.

### 2.1. *Speakers*

The participants measured in this study were all monolingual undergraduate students of University College Utrecht with Dutch as an L1. There were 20 participants, 13 of whom were female and 7 male. The age range of the participants was 17-20 at the first recording session, meaning their age range was about 20-23 during the last recording session. All Dutch students in the LUCEA corpus who identify as bilingual were excluded from this study. The only L1 Dutch speakers measured are those who grew up speaking only Dutch (and/or perhaps a non-standard variety of Dutch) before the age of 8 (the critical period). None of these L1 Dutch speakers spoke in accents or dialects that differ considerably from Standard Dutch.

### 2.2 *Recording Equipment*

Recordings were made in a quiet furnished office, using a close-talking microphone (Sennheiser Headset HSP 2ew), via a Saffire Pro 40 multichannel AD converter and preamplifier, using Audacity, open source software for recording and editing sounds (see http://audacity.sourceforge.net). The sampling frequency for all recordings is 44100 Hz with a bit rate of 16 bits/sample (96 dB).

### 2.3 *Materials*

Informal monologues in Dutch and English were extracted from recordings 1 and 5 (the beginning of the 1st semester and the end of the last semester) for each participant. These consist of at least 2 minutes of spontaneous speech on informal topics, such as leisure activities, travel and travel plans. Approximately 1 minute of speech per monologue per recording was used for analysis. For some participants more time was taken into account due to a too limited amount of data extractable from 1 minute only.

From these monologues, all /s/, /d/ and /t/ samples were extracted for analysis. Only those /s/ were included for which the canonical target phoneme was /s/, i.e., realisations of [s] stemming from coarticulation, devoicing of /z/ as part of a non-standard accent of Dutch, etc, were not included. Since, naturally, not every speaker has used the same words in her or his monologue, there is some variation in the quantity of /s/ samples per recording. Almost all tokens of [s] with the underlying phoneme /s/ from 30 seconds into to the end of the monologue were taken into account.

All /d/ samples sounding like /t/ were measured as though they were /d/, basing the classification of a sound on the underlying category for the sound once more. In the L2 English recordings, all /θ/ realised as /t/ (as in 'think': /tɪŋk/) and all /ð/ realised as /d/ (as in 'that': /dɛt/) were excluded as samples of /d/ and /t/ due to different underlying phonetic categories. As for the /s/ samples, there are rather large differences in quantity of /d/ and /t/ samples per recording. Especially for the L2 recordings, finding sufficient examples of word-initial /d/ was sometimes problematic. This is probably due to a smaller number of words with word-initial /d/ occurring frequently in English. For some of the recordings, more time was taken into account in case there were too few /d/ samples in the time span from 30 seconds to 2 minutes[2].

*2.4 Data Collection*

All measurements were carried out using the Praat programme for phonetic analysis. The start of the analytical process entailed the extraction of all samples of /s/ and word-initial /d/ and /t/ for all monologues. All Praat scripts were written by Georg Lohfink[3]. The /s/ samples were annotated with the help of the script 'fricative_detector_for_filelist2.4.PRAAT'. The annotations made with this fricative detector script were then used for the extraction of /s/ samples with the script 'fricative_extractor_from_30_seconds_onwards.PRAAT'. English /s/ samples and female Dutch /s/ samples were sorted with 'sorting_tds_with_statistic3.PRAAT' while all Dutch samples for the males were extracted (after annotation) with a script named 'sorting_s.PRAAT'.

All annotations of VOT values for word-initial /d/ and /t/ samples were done manually in Praat. This was done for recordings 1 and 5 for each participant in the study, in both the L1 and the L2. For /t/, the start of the burst to the onset of the vowel was measured as VOT. For VOT values for /d/, the entirety of the sound (i.e.: prevoicing and burst) was annotated. Later this appeared to be highly impractical for the measurement of VOT. Annotations were then made in more detail, selecting both prevoicing (if present) and the burst (until the onset of the vowel) of the /d/ sound. For the measurement of VOT durations for /d/ and /t/, the script named 'get_intervals_lengths.PRAAT' was used.

*2.5 Statistical Analysis*

R (R Core Team, 2012) and lme4 (Bates, Maechler & Bolker, 2012) were used to perform an analysis of the dependent variable and the main effects of recording, language and gender. The same programme and function were used to perform a similar analysis of the correlation between the dependent variable VOT and the main effects of recording, language and gender. As random slopes, recording and language were entered. There were random intercepts for speakers and words.

[2] Up to 20 seconds more speaking time was analysed for s103f5, s106f5, s114f5, s115f1, s119f5, s127m1, s130m5, s131f5, s139f1, s155f1, s163f1, s163f5, s167f5, s171m1 & s171m5.
[3] See appendix for all Praat scripts.

# 3 Results

## *3.1 Centre of gravity for /s/*

There were 2249 observations of /s/ for all 20 speakers. From a total of 888 different words, the ones used most frequently were ‘was’, ‘is’ and ‘dus’ (so) in Dutch, and ‘was’, ‘is’ and ‘so’ in English. Counter to the expectations raised by the relevant literature, there was no significant change in centre of gravity in the 5$^{th}$ recording compared to the 1$^{st}$, for Dutch or for English.

There seems to be hardly any change in centre of gravity for either language from recording 1 to 5. By additional analysis of individual results (shown below), it can be concluded that there is no statistically significant change for the centre of gravity for /s/. By mixed effect analysis it was shown that the t value for centre of gravity change per language per recording was 1.341. This absence of interaction between language and recording in terms of centre of gravity of /s/ makes it quite unlikely that L1 attrition is at work in between the 1$^{st}$ and the 5$^{th}$ recording session.

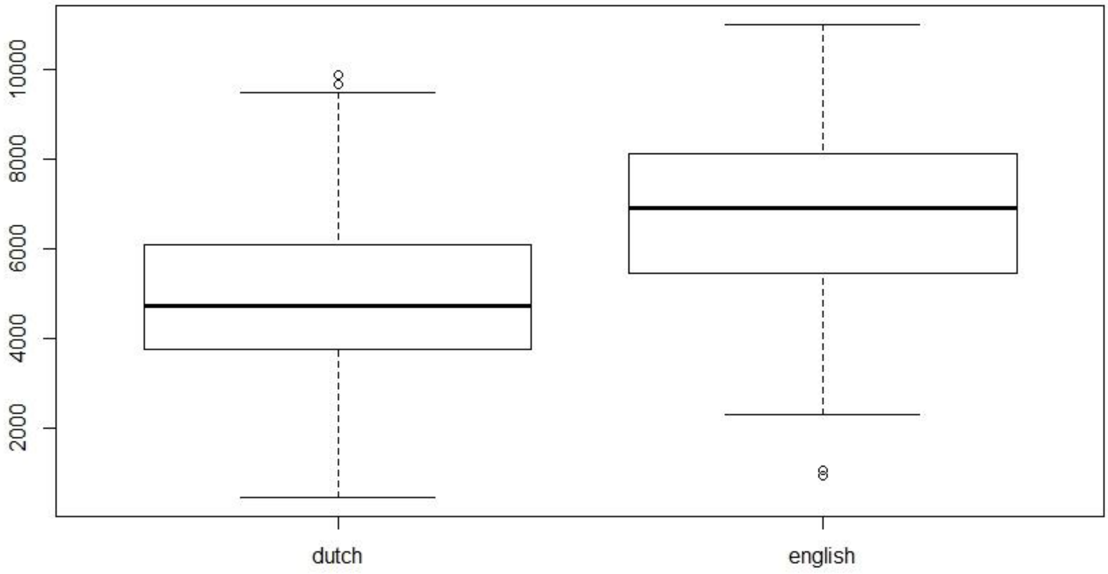
*Table 1. Centre of gravity per speaker by language by recording*

| | Rec. | Dutch | Increase (>)/ Decrease (<) | English | Increase (>)/ Decrease (<) |
|---|---|---|---|---|---|
| S103f | 1<br>5 | 5576.264<br>5640.952 | > | 7349.668<br>6791.751 | < |
| S106f | 1<br>5 | 6542.012<br>6403.488 | < | 7870.749<br>7996.127 | > |
| S107f | 1<br>5 | 4647.305<br>4254.796 | < | 6474.423<br>5576.217 | < |
| S114f | 1<br>5 | 5234.683<br>4408.095 | < | 6576.139<br>6894.814 | > |
| s115f | 1<br>5 | 7010.765<br>6783.439 | < | 8782.264<br>8477.240 | < |
| S119f | 1<br>5 | 3692.179<br>4748.811 | > | 7078.698<br>6925.522 | < |
| S127m | 1<br>5 | 3769.497<br>4240.112 | > | 6062.427<br>5830.661 | < |
| S130m | 1<br>5 | 3595.855<br>3136.164 | < | 3790.629<br>4115.975 | > |
| s131m | 1<br>5 | 4169.344<br>5528.292 | > | 5084.125<br>6094.332 | > |
| S132 | 1 | 4262.145 | < | 5871.853 | > |

| | | | | | |
|---|---|---|---|---|---|
| m | 5 | 3986.033 | | 6136.150 | |
| S134<br>m | 1<br>5 | 4289.089<br>4041.842 | < | 5435.349<br>5431.250 | < |
| S136<br>m | 1<br>5 | 4827.566<br>6056.297 | > | 6330.678<br>7321.869 | > |
| S138<br>m | 1<br>5 | 3746.306<br>3873.856 | > | 5303.492<br>5445.820 | > |
| S139f | 1<br>5 | 7412.963<br>6910.271 | < | 8182.137<br>7850.010 | < |
| S155f | 1<br>5 | 6049.578<br>7093.227 | > | 7015.351<br>7682.644 | > |
| S163f | 1<br>5 | 6256.184<br>5418.654 | < | 8682.098<br>7543.057 | < |
| s167f | 1<br>5 | 7209.893<br>6872.654 | < | 8660.737<br>7876.682 | < |
| s168f | 1<br>5 | 5176.315<br>5759.320 | > | 7788.358<br>7969.792 | > |
| s171f | 1<br>5 | 4244.392<br>3628.442 | < | 5040.634<br>4220.944 | < |
| s177m | 1<br>5 | 4588.013<br>4899.282 | > | 7074.479<br>7596.552 | > |

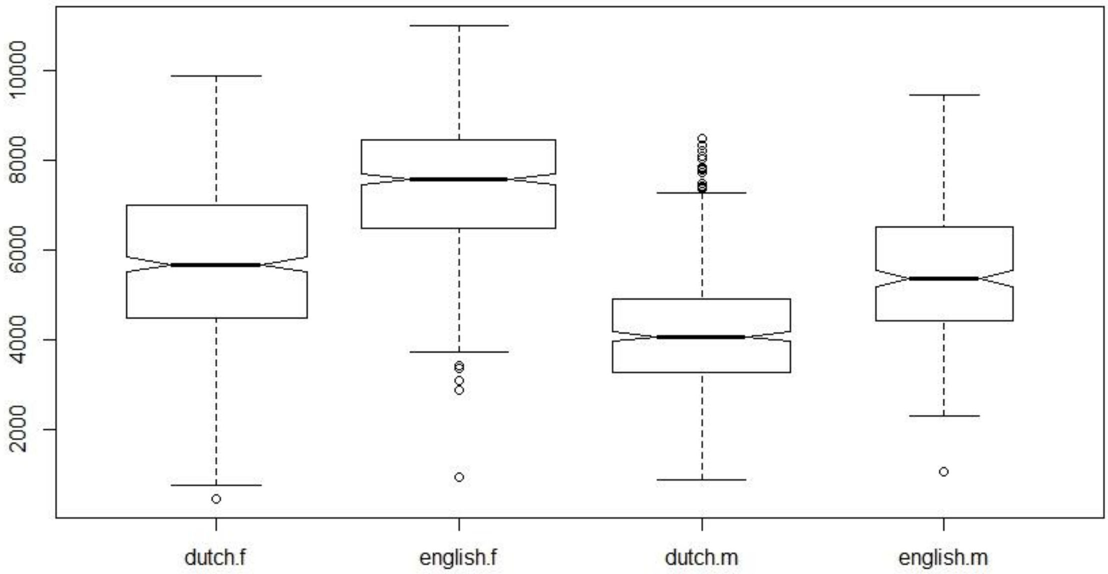
However, the mean centres of gravity in Dutch and English respectively confirmed the hypothesis that the Dutch /s/ has a lower centre of gravity than the English one. As mentioned before, most of the sound energy for /s/ is above 4 kHz, whereas for /ʃ/ it is around 2,000 Hz and above. A linear mixed effects model fit by REML (lmer) of the main effect of recording, language and gender shows that the mean centre of gravity for /s/ across all recordings of the 20 L1 Dutch speakers in the present study was around 5674.94 Hz in Dutch, and 7429.94 Hz in English. This difference is strikingly statistically significant with a t value of 8.452. The mean centre of gravity varied per word and per speaker. The regression coefficient varied across recordings (349845), and across speakers (406587).

**Figure 1. Centre of gravity by language**




A significant difference can be observed between males and females when it comes to the centre of gravity for the Dutch and English /s/. For both Dutch and English, the centre of gravity for /s/ is higher for females (a little under 6000 for Dutch and around 7800 for English) than for males (around 4000 for Dutch and around 5200 for English). The main effect of gender was that male speakers have a 1559.86 Hz lower centre of gravity for /s/ than women in both English and Dutch. It seems that the female students make an acoustically larger distinction between their /s/ in Dutch and English than the males do, with a deviance from the females' distinction between the two /s/ sounds of -479.52.

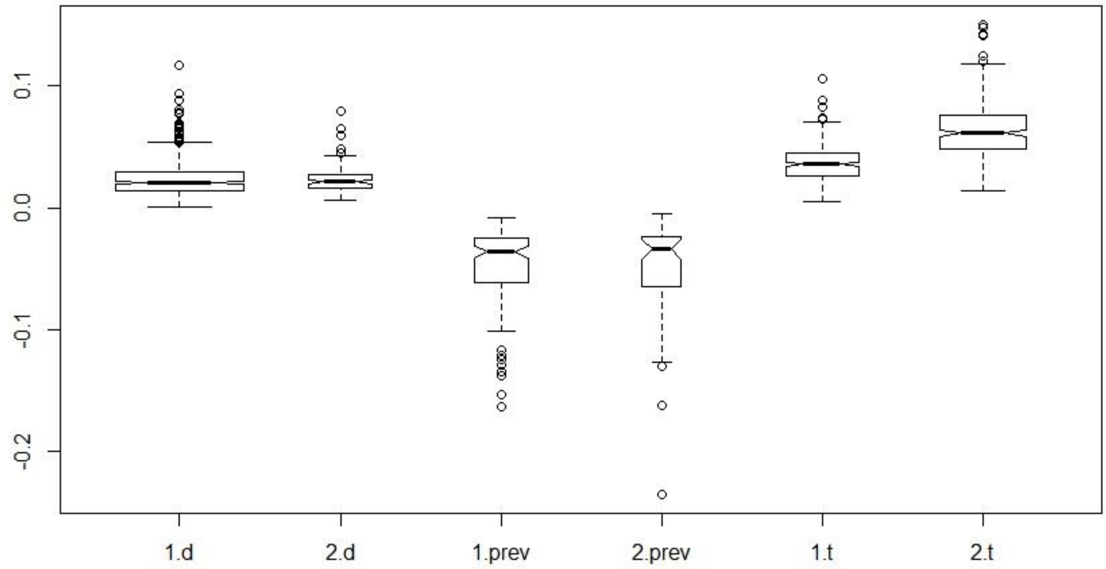
**Fig. 2 Centre of gravity for /s/ by gender and language**



*3.2 VOT for /d/ and /t/*

For mean VOT values in both Dutch (L1) and English (L2) no significant change was measured between the 1st and the 5th recording session. For /d/, there was no significant language-dependent difference in duration of the burst or duration of prevoicing. It must be noted, however, that there were fewer instances of prevoicing in English than there were in Dutch. This was to be expected from the knowledge previous studies have acquired about the relatively large amount and duration of prevoicing in Dutch as opposed to English (Van Alphen, 2007). There was, however, a clear distinction between VOT values for /t/ in Dutch and English; the mean VOT value for /t/ in English is significantly longer (by 28.5 ms, or 0.0282 s., and a t value of 7.3) than in Dutch.

**Fig. 3 VOT per phoneme in Dutch (1) and English (2)**




# 4 Discussion

In contrast with the studies on the topic of phonetic drift in a person's first language as a response to second language acquisition discussed in the introduction, it seems that there is no correlation between phonetic drift from native-sounding /d/, /t/ and /s/ and increasing proficiency or frequent use of English for the L1 Dutch speakers examined in this study. There was no significant correlation between an increase of centre of gravity for /s/ in English and a decrease in Dutch (dissimilation) or an increase in Dutch and a decrease in English (assimilation). Although the duration of VOT for word-initial /t/ was significantly longer in English than in Dutch, there was no change in VOT durations for either Dutch or English word-initial /t/ or /d/ between recordings 1 and 5. Therefore no process of assimilation or dissimilation as described by Flege's (1987) Speech Learning Model seems to occur for either /s/ or the word-initial dental plosives, and L1 attrition seems not to occur for the Dutch speakers in the corpus.

Although the mean centre of gravity for /s/ did not change from recording 1 to 5, a strikingly significant difference in centre of gravity for /s/ was observed between the English and the Dutch recordings for all participants. After statistical analysis it may be concluded that all of the Dutch speakers from this study are able to produce the difference in 'sharpness' of /s/ in Dutch and English, whether or not they are consciously aware of making this differentiation for the two languages. The results from this study provide acoustic support for Collins & Mees' (2013) theory that the /s/ in Dutch is more palatal, and therefore more /ʃ/-like than the /s/ in English. Since speakers already exhibit this differentiation in their first recording, they must have been able to produce the different /s/ sounds in Dutch and English with some accuracy before their time of studying at University College Utrecht (and possibly learning about the difference through frequent use of English). It is therefore not unlikely that Dutch speakers are subconsciously aware of the difference between the Dutch and English categories of /s/.

Quite unexpectedly, there also seemed to be a strong effect of gender with regards to centre of gravity. The centre of gravity for /s/ in both English and Dutch was higher for female speakers than for male speakers. There are several possible explanations for this gender difference. The difference in frequency of the /s/ sound which affects the centre of gravity might be merely a result of the fact that females generally have a higher voice pitch than males. However, from the plots of centre of gravity for males and females it was shown that there is considerable overlap for many /s/ samples and their centre of gravity between the males and females. The mean centre of gravity for the English /s/ realised by males was almost equal to the centre of gravity for Dutch /s/ that women produced. This implies that the men are, in fact, able to produce centres of gravity at the same frequency as the women (for instance by change in tongue position and lips posture). Therefore, the difference in centre of gravity between genders cannot be ascribed merely to biological differences such as vocal tract length or larynx position. If both male and female speakers can control their centre of gravity production despite possible biological differences, which the results of this study suggest, then the difference in centre of gravity between genders probably has to do with sociolinguistic factors.

Men's larynxes are usually lower than women's, but speakers could potentially exaggerate the difference in vocal pitch this results in to project a gender identity (Thomas, 2011: 239). Similarly, speakers would be able to adapt their centre of gravity, for instance as a part of gender identity performance. The fact that the female participants made the difference in centre of gravity for their Dutch and English /s/ larger than the male participants could have its origin in the tendency that has been observed for women to speak "more correctly" than men. It is likely that their /s/ in English is considerably sharper in comparison with their Dutch /s/ because they want to make as large of a distinction between the two categories of /s/ as possible to sound as native-like or correct as possible. A rather sharp /s/ in English would then be an indicator of such an attempt, which is exhibited by the females, but not by the males. Robin Lakoff (1975) describes "hypercorrect grammar and pronunciation" as a feature of typical "women's speech", which is equated with "powerless speech" in many gender and language studies from the 70s, 80s and 90s. This means there is a pressure on women to "speak properly" which does not exist in the same way for men; unlike men, women are not supposed to swear, and they are expected to be more correct in their grammar and pronunciation.

By informal observation in everyday life, I hypothesise that the sharp /s/ in Dutch is associated with femininity, particularly for adolescent females. Rather /ʃ/-like realisations of /s/, or even substitution of all /s/ by /ʃ/ is a characteristic mostly of non-Standard and non-prestige varieties of Dutch, such as the Amsterdam dialect (Schatz, 1987). As in many societies, there is considerable stigma in the Netherlands surrounding non-Standard varieties of Dutch, as it is often associated with the working classes and lack of education. As described by Trudgill (1988), working class language and culture is often associated with roughness and masculinity (21-22). This statement is in accordance with Gordon's (1997) argument that women use more standard forms to counter the negative stereotypes (such as sexual immorality) associated with women who use nonstandard forms. Whatever the reason, women across cultures seem to be more likely to use prestige forms of language. Perhaps the association of a sharp /s/ with English also makes young female speakers who use this /s/ sound more metropolitan or internationally oriented. This, in turn, might increase their eligibility for jobs in an international context or for higher positions within companies which are often still harder to obtain for women than for men.

A study by Morris et al. (2008) revealed that there were no significantly different VOTs for initial plosives /ptk/ and /bdg/ between male and female adult speakers of English. This might explain why for the Dutch L2 English speakers in this study there were no significant differences in VOT for /d/ or /t/ related to gender. VOT values, for some reason, appear not to be dependent on gender. This insignificance of gender is striking when compared with the significant difference in sharpness for English /s/ that females produce in comparison to males. Several earlier studies have shown that /s/ skewness and centre of gravity were important parameters by which femininity or masculinity and sexual orientation were judged by listeners. Notably F1 frequency and /s/ skewness were strongly predictive of perceived sexual orientation, particularly for male speakers. The higher the frequency for /s/, the more "gay" a speaker sounded according to listeners (Munson et al., 2006). This observation seems to reinforce the popular belief that there is such a thing as "the gay lisp"; a lisp for the /s/ that homosexual men use. The sharper a realisation of /s/ is, the closer it comes to being dental, and the more it approximates a "gay lisp". Vowel-space dispersion and /s/ centre of gravity predicted perceived femininity beyond voice pitch (more specifically F0 and F2 frequency). However, Munson et al.'s study (2006) found that perceived sexual orientation in women's speech and perceived femininity are different constructs, whereas for men a decrease of perceived masculinity seems to be more correlated with perceived homosexuality. Perceived femininity judgments were affected by the types of sounds in the stimuli; "listeners rated women as less-feminine sounding when making ratings from words with sibilant fricatives than when making ratings from words without these sounds" (Munson et al., 2006: 19). Since high frequency /s/ seems to be associated with femininity in English, women would need to exaggerate the sharpness of /s/ to still be considered feminine when using sibilant fricatives. This could account for the tendency for Dutch women at University College Utrecht to produce /s/ in English with a very high centre of gravity.

If, as I hypothesise, a sharp /s/ is a characteristic of femininity for women and homosexual orientation for men, then this might provide a reason for women to have sharper, more alveolar realisations of /s/ (with a higher centre of gravity), while Dutch men have more palatalised realisations of /s/ (with a lower centre of gravity). If they produced sharper /s/ sounds they would be more likely to be judged as "gay", particularly in Dutch because centre of gravity for /s/ in this language is relatively low, as was shown in the present study. Most heterosexual men would find this very undesirable, since their being perceived as gay is often felt as a reduction of their masculinity, and a downgrading of their status. According to Trudgill (1988), male speakers are subconsciously more concerned with acquiring prestige of the covert sort and with signalling group solidarity than with obtaining social status [meaning socio-economic status in this context] (26). Therefore, if a non-standard /ʃ/-like pronunciation of /s/ is a means of obtaining covert prestige associated with roughness and masculinity, then it makes sense for men to produce /s/ in a way that is less standard. The unspoken rule that women should speak correctly and use sophisticated language then explains why women make a clearer distinction between Dutch and English /s/, thus creating two neat categories for each individual language. The pronunciation of the phoneme /s/ in Dutch and English therefore seems to be associated with sociolinguistic standards associated with gender and gender stereotypes.

*Limitations*

A factor that can be problematic in this kind of segmental phonetics research is the use of samples of spontaneous speech. It was difficult to obtain equal amounts of data, and the same kind of data (e.g.: all /s/ which are not in clusters, all word-initial, etc.) for all participants, which made comparative analysis across individual speakers slightly more problematic.

Due to the relatively small dataset for this study (20 speakers), it is difficult to draw any conclusions about Dutch women and men's /s/ realisations for Dutch and English in general. The results, however, may be quite an accurate representation of /s/ realisations for adolescent Dutch university students who are relatively proficient in English.

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# Appendix

## Praat scripts (Georg Lohfink)

*Fricative_detector_for_filelist2.4.PRAAT*

```
### Default Directories

originals$ = "/home/georg/UCU corpus/several_samples_per_wav/l1/"

### Output
editable_annotations$ = "/home/georg/UCU
corpus/several_samples_per_wav/detector_annots/s/"
data_tables$ = "/home/georg/UCU
corpus/several_samples_per_wav/test_praat_script_files/table/"

## Default settings

gravity_threshold_f = 2500
s_centre_of_gravity_threshold = 2700
intensity_threshold_lower = 45
pre_filter = 100

########################################################################
#####################



beginPause: "Settings"

      real: "Minimum Intensity in dB", intensity_threshold_lower
      real: "Min Frequency Centre for F", gravity_threshold_f
      real: "Min Frequency Centre for S", s_centre_of_gravity_threshold
      real: "Low Frequency Threshold", pre_filter
      sentence: "Input Folder", originals$
      choice: "Save Output", 1
            option: "yes"
             option: "no"
            option: "just the table"
            option: "just annotations"
      sentence: "Output Tables", data_tables$
      sentence: "Output Annotations", editable_annotations$
clicked = endPause: "Continue", 2



originals$ = input_Folder$
editable_annotations$ = output_Annotations$
data_tables$ = output_Tables$

gravity_threshold_f = min_Frequency_Centre_for_F
s_centre_of_gravity_threshold = min_Frequency_Centre_for_S
intensity_threshold_lower = minimum_Intensity_in_dB
pre_filter = low_Frequency_Threshold

########
if right$(originals$,1) != "\" and  right$(originals$,1) != "/"
```

```
      originals$ = originals$ + "/"
endif



called_from_other_script = 1
Create Strings as file list: "fileList", originals$+"*.wav"
number_files = Get number of strings
appendInfoLine: number_files, " files"




for file from 1 to number_files

      select Strings fileList
      filename$ = Get string: file
      raw_filename$ = left$(filename$,length(filename$)-4)
      appendInfoLine: raw_filename$

      sound = Read from file: originals$+filename$

include fricative_detector2.4.praat

      if save_Output = 1 or save_Output = 4
             if right$(editable_annotations$,1) != "\" and
right$(editable_annotations$,1) != "/"
                  editable_annotations$ = editable_annotations$ + "/"
            endif
            selectObject: "TextGrid sound"
            Save as text file: editable_annotations$ + raw_filename$
+".TextGrid"
      endif
      if  save_Output = 1 or save_Output = 3
            x$ = "blaa/d"
                  if right$(data_tables$,1) != "\" and
right$(data_tables$,1) != "/"
                        data_tables$ = data_tables$ + "/"
                  endif


            selectObject: "Table data_table"
            Save as tab-separated file: data_tables$ + raw_filename$
+".Table"
      endif
      if save_Output != 2
            selectObject: sound
            Remove
      endif

endfor



###################
```

*Fricative_extractor_from_30_seconds_onwards.PRAAT*

```
###### INFO
##############################################################################
##########
##   You'll need three folders for this part.  Change the directories
below accordingly.  Every directory should be included in inverted
commas
#    and end with a forward slash.  Please don't change anything else.
#
#          1.   originals$                  This is where you put the
l1 monologue files.  It's important that this folder only contains wav-
files
#                                                 for which you also
have the correct annotation file.
#          2.   editable_annotations$            Annotations go in
here.  I'll send you those.
#
#          3.   extracts$                   This is an empty folder.
The script will automatically add a few subfolders.
#                                           You'll also need its
directory for the sorting script.


#  keep these variable names      ####    Just change these three
directories



                                                                    ####
                                                                    ####

                                                                    ####
                                                              ##########
                                                                ########

######
                                                                    ####
                                                                      ##

#

originals$ =     "C:/Users/Jacky-Zoë/Documents/files_tds_females/"
editable_annotations$ = "C:/Users/Jacky-
Zoë/Documents/annotations_tds_females/"
extracts$ = "C:/Users/Jacky-Zoë/Documents/extracts_tds_females/"



                                                                    #
                                                                     ##
                                                                   ####
                                                                 ######
                                                              ########

##########
                                                                    ###
                                                                    ###
```

```
                                                                      ###
                                                                      ###
# You can specify a time (in seconds) in the variable 'start_from'.
# Currently, the script starts extracting samples which occur after the
first 30 seconds of the original file
start_from = 30
finish_at = 90


#######################################################################
#########################################################

extract_tier = 3

long_extracts$ = extracts$ + "long_extracts/"
short_extracts$ =  extracts$ + "short_extracts/"
longer_extracts$ =  extracts$ +  "longer_extracts/"
temp$ =  extracts$ +  "temp/"


createDirectory: long_extracts$
createDirectory: short_extracts$
createDirectory: longer_extracts$
createDirectory: temp$



Create Strings as file list: "fileList", originals$+"*.wav"


number_files = Get number of strings

appendInfoLine: number_files, " files"


for file from 1 to number_files

      select Strings fileList
      filename$ = Get string: file
      raw_filename$ = left$(filename$,length(filename$)-4)
      appendInfoLine: raw_filename$
      sound = Read from file: originals$+filename$
      Scale intensity: 65
      annotation = Read from file:
editable_annotations$+raw_filename$+".TextGrid"
      number_of_intervals = Get number of intervals: extract_tier
      for interval from 1 to number_of_intervals
            selectObject: annotation
            interval_name$ = Get label of interval: extract_tier,
interval

            if interval_name$ = "extract"
                  xmin = Get start point: extract_tier, interval
                  xmax = Get end point: extract_tier, interval
                  if xmin > start_from
                        if xmax < finish_at
                              selectObject: sound
```

```
                              short_extract = Extract part: xmin, xmax,
"rectangular", 1, "no"
                              Save as WAV file: short_extracts$ +
raw_filename$ + "_"+ left$(string$(xmin),7)+".wav"
                              Remove
                              selectObject: sound
                              long_extract = Extract part: xmin-0.025,
xmax+0.5, "rectangular", 1, "no"
                              Save as WAV file: long_extracts$ +
raw_filename$ + "_"+ left$(string$(xmin),7)+".wav"
                              Remove
                              selectObject: sound
                              longer_extract = Extract part: xmin-0.5,
xmax+0.6, "rectangular", 1, "no"
                              Save as WAV file: longer_extracts$ +
raw_filename$ + "_"+ left$(string$(xmin),7)+".wav"
                              Remove
                              selectObject: sound
                              temp_extract = Extract part: xmin-0.2,
xmax+0.2, "rectangular", 1, "no"
                              Save as WAV file: temp$ + raw_filename$ +
"_"+ left$(string$(xmin),7)+".wav"
                              Remove
                        endif
                  endif
            endif

      endfor
      selectObject: sound

endfor


appendInfoLine: "----Done----"
```

*Sorting_tds_with_statistic3.PRAAT*

```
#########    INFO #######
#    You'll need four folders.  You can copy and paste the directories
for the first three from the 'fricative_extractor' script.
Furthermore, you
#    need to specify an empty folder for output.



long_extracts$ =                           "/home/georg/UCU
corpus/several_samples_per_wav/english sorting/extracts/long_extracts/"
short_extracts$ =                          "/home/georg/UCU
corpus/several_samples_per_wav/english
sorting/extracts/short_extracts/"
longer_extracts$ =                         "/home/georg/UCU
corpus/several_samples_per_wav/english
sorting/extracts/longer_extracts/"

output$ =                                  "/home/georg/UCU
corpus/several_samples_per_wav/english sorting/sorting output/"



###################################
#######################################################################
###################
soundname$ = "s"
soundname2$ = "t"
soundname3$ = "d"
originals$ = short_extracts$


accept_directory$ = output$ +soundname$+"/"
else1_directory$ = output$ +soundname2$+"/"
else2_directory$ = output$ +soundname3$+"/"

reject_directory$ = output$ + "reject/"
createDirectory: accept_directory$
createDirectory: else1_directory$
createDirectory: else2_directory$
createDirectory: reject_directory$





stats_table_file$ = output$+"stats.Table"
if fileReadable (stats_table_file$)
     stats_table= Read from file: stats_table_file$
else
     stats_table = Create Table with column names: "stats", 0,
"filename sound word comment accepted t d intensity centre_of_gravity
sd"

endif
```

```
Create Strings as file list: "fileList", originals$+"/*.wav"
number_files = Get number of strings
appendInfoLine: number_files, "files"


# initial means for accepted samples: will be overwritten after first
sample is accepted
mean_intensity = 50
mean_centre_of_gravity = 5000
mean_sd = 2500
sd_intensity= 1
sd_centre_of_gravity = 1
sd_sd = 1




### create stats table
for file from 1 to number_files
      select Strings fileList
      filename$ = Get string: file
      #appendInfoLine: filename$

      selectObject: stats_table
      file_in_table = Search column: "filename", filename$
      if file_in_table = 0

            original = Read from file: originals$+filename$
            sample_length = Get total duration
            if sample_length > 0.07
                  max_edges = (sample_length-0.07)/2
                  if max_edges > 0.02
                        max_edges = 0.02
                  endif
                  Extract part: max_edges, sample_length-max_edges,
"rectangular", 1, "no"



            endif

            sample_intensity =Get intensity (dB)
            #appendInfoLine: sample_intensity
            sample_spectrum = To Spectrum: "yes"
            sample_centre_of_gravity=Get centre of gravity: 2
            #appendInfoLine: sample_centre_of_gravity
            sample_sd = Get standard deviation: 2
            #appendInfoLine: sample_sd


            plusObject: original
            Remove
            ##
            select stats_table
            Append row
            last_row = Get number of rows
```

```
            Set string value: last_row, "filename", filename$
            Set string value: last_row, "word", "?"
            Set string value: last_row, "word", "?"
            Set string value: last_row, "comment", "?"
            Set string value: last_row, "accepted", "not_sorted_yet"
            Set string value: last_row, "intensity",
string$(sample_intensity)
            Set string value: last_row, "centre_of_gravity",
string$(sample_centre_of_gravity)
            Set string value: last_row, "sd", string$(sample_sd)
            Save as tab-separated file: stats_table_file$
      endif


endfor

stats_length = Get number of rows

######


select all
Remove

stats_table= Read from file: stats_table_file$


rejected_in_a_row = 0

sort_by_nr = 1


start_from = 1

for file from start_from to number_files
      if sort_by_nr = 1
            sort_by$ = "intensity"
            mean_sort_by = mean_intensity
            sort_sd = sd_intensity
            appendInfoLine: "by "+sort_by$
      elsif sort_by_nr = 2
            sort_by$ = "centre_of_gravity"
            mean_sort_by = mean_centre_of_gravity
            sort_sd = sd_centre_of_gravity
            appendInfoLine: "by "+sort_by$
      elsif sort_by_nr = 3
            sort_by$ = "sd"
            mean_sort_by = mean_sd
            sort_sd = sd_sd
            appendInfoLine: "by "+sort_by$
      endif

      if rejected_in_a_row > 2
            sort_by_nr = sort_by_nr + 1
            appendInfoLine: string$(rejected_in_a_row)+" rejections in a
row"
            rejected_in_a_row =0
            if sort_by_nr >3
```

```
			sort_by_nr = 1
		endif

		appendInfoLine: "sorting criterion changed"
	endif
	most_similar_file =1
	most_similar_file_mean_distance = 99999999
	selectObject: stats_table
	for row from 1 to stats_length
		accepted$ = Get value: row, "accepted"
		if accepted$ = "not_sorted_yet"
			sample_measure = Get value: row, sort_by$

			if sqrt((mean_sort_by-sample_measure)**2)<
most_similar_file_mean_distance
				most_similar_file_mean_distance =
sqrt((mean_sort_by-sample_measure)**2)
				most_similar_file = row
				#appendInfoLine: sample_measure
				#appendInfoLine: mean_sort_by
				mean_sample_difference = mean_sort_by-
sample_measure

			endif

		endif

	endfor


	mean_sample_difference = sqrt((mean_sample_difference)**2)/sort_sd
	appendInfoLine: "Sample differs from mean by "+
string$(mean_sample_difference) + " sd"


	filename$ = Get value: most_similar_file, "filename"

	selectObject: stats_table
	row_number = Search column: "filename", filename$
	sorted_yet$ = Get value: row_number, "accepted"
	if sorted_yet$ = "not_sorted_yet"


		appendInfoLine: "---"
		long_sound = Read from file: long_extracts$+filename$
		longer_sound = Read from file: longer_extracts$+filename$
		original = Read from file: originals$+filename$
		appendInfoLine: filename$
		clicked = 3
		selectObject: longer_sound
		Edit
		while clicked = 3 or clicked = 4

			if clicked = 4
				selectObject: longer_sound

				Play
			else
```

```
                    selectObject: original
                    Play
                    Play
                    selectObject: long_sound
                    Play
                endif
                beginPause: "save, reject or replay"
                    comment: "Please type in the word you're hearing.
If you want to reject the sample, you can leave this field empty."

                    sentence: "word", ""
                    comment: "Comments are optional."
                    sentence: "comments", "-"
                clicked = endPause: "save", "reject", "play
again","long sample", "t", "d", 0

            endwhile

            if clicked = 1
                Save as WAV file: accept_directory$+filename$
                rejected_in_a_row = 0
                selectObject: stats_table
                row_number = Search column: "filename", filename$
                Set string value: row_number, "filename", filename$
                Set string value: row_number, "sound", soundname$
                Set string value: row_number, "word", word$
                Set string value: row_number, "comment", comments$
                Set string value: row_number, "accepted", string$(1)
                Set string value: row_number, "t", string$(0)
                Set string value: row_number, "d", string$(0)
                Save as tab-separated file: stats_table_file$
                selectObject: stats_table
                number_of_accepted = 0
                mean_intensity = 0
                mean_centre_of_gravity = 0
                mean_sd = 0
                for row from 1 to stats_length
                    accepted = Get value: row, "accepted"
                    if accepted = 1
                        sample_intensity = Get value: row,
"intensity"
                        sample_centre_of_gravity = Get value: row,
"centre_of_gravity"
                        sample_sd = Get value: row, "sd"

                        mean_intensity = mean_intensity +
sample_intensity
                        mean_centre_of_gravity =
mean_centre_of_gravity + sample_centre_of_gravity
                        mean_sd = mean_sd + sample_sd
                        number_of_accepted = number_of_accepted + 1
                    endif

                endfor
                mean_intensity = mean_intensity/number_of_accepted
                mean_centre_of_gravity =
mean_centre_of_gravity/number_of_accepted
                mean_sd = mean_sd/number_of_accepted
```

```
                writeInfoLine: "mean:"
                appendInfoLine: mean_intensity
                appendInfoLine: mean_centre_of_gravity
                appendInfoLine: mean_sd

                squared_intensity_deviation = 0
                squared_centre_of_gravity_deviation = 0
                squared_sd_deviation = 0
                for row from 1 to stats_length
                     accepted = Get value: row, "accepted"
                     if accepted = 1
                          sample_intensity = Get value: row,
"intensity"
                          sample_centre_of_gravity = Get value: row,
"centre_of_gravity"
                          sample_sd = Get value: row, "sd"
                          sample_squared_intensity_deviation=
(mean_intensity - sample_intensity)**2
                          squared_intensity_deviation =
squared_intensity_deviation + sample_squared_intensity_deviation
                          sample_squared_centre_of_gravity_deviation=
(mean_centre_of_gravity - sample_centre_of_gravity)**2
                          squared_centre_of_gravity_deviation =
squared_centre_of_gravity_deviation +
sample_squared_centre_of_gravity_deviation
                          sample_squared_sd_deviation= (mean_sd -
sample_sd)**2
                          squared_sd_deviation = squared_sd_deviation
+ sample_squared_sd_deviation

                     endif

                endfor
                sd_intensity =
sqrt(squared_intensity_deviation/number_of_accepted)
                sd_centre_of_gravity =
sqrt(squared_centre_of_gravity_deviation/number_of_accepted)
                sd_sd = sqrt(squared_sd_deviation/number_of_accepted)
                appendInfoLine: "sd :"
                appendInfoLine: sd_intensity
                appendInfoLine: sd_centre_of_gravity
                appendInfoLine: sd_sd



           elsif clicked = 2
                Save as WAV file: reject_directory$+filename$
                rejected_in_a_row = rejected_in_a_row +1
                selectObject: stats_table
                row_number = Search column: "filename", filename$
                Set string value: row_number, "filename", filename$
                Set string value: row_number, "sound", "rejected"
                Set string value: row_number, "word", word$
                Set string value: row_number, "comment", comments$
                Set string value: row_number, "accepted", string$(0)
                Set string value: row_number, "t", string$(0)
                Set string value: row_number, "d", string$(0)
                Save as tab-separated file: stats_table_file$
```

```
                writeInfoLine: ""


        elsif clicked = 5
                Save as WAV file: else1_directory$+filename$
                selectObject: stats_table
                row_number = Search column: "filename", filename$
                Set string value: row_number, "filename", filename$
                Set string value: row_number, "sound", soundname2$
                Set string value: row_number, "word", word$
                Set string value: row_number, "comment", comments$
                Set string value: row_number, "accepted", string$(0)
                Set string value: row_number, "t", string$(1)
                Set string value: row_number, "d", string$(0)
                Save as tab-separated file: stats_table_file$
                writeInfoLine: ""
        elsif clicked = 6
                Save as WAV file: else2_directory$+filename$
                rejected_in_a_row = rejected_in_a_row +1
                selectObject: stats_table
                row_number = Search column: "filename", filename$
                Set string value: row_number, "filename", filename$
                Set string value: row_number, "sound", soundname3$
                Set string value: row_number, "word", word$
                Set string value: row_number, "comment", comments$
                Set string value: row_number, "accepted", string$(0)
                Set string value: row_number, "t", string$(0)
                Set string value: row_number, "d", string$(1)
                Save as tab-separated file: stats_table_file$
                writeInfoLine: ""



        endif
        appendInfoLine: "rejected in a row: " +
string$(rejected_in_a_row)

        selectObject: original
        plusObject: long_sound
        plusObject: longer_sound
        Remove
    else
        appendInfoLine: filename$+"   already sorted"


    endif

endfor
```

*Sorting_s.PRAAT*

```
#########    INFO #######
#     You'll need four folders.  You can copy and paste the directories
for the first three from the 'fricative_extractor' script.
Furthermore, you
#     need to specify an empty folder for output.



long_extracts$ = "C:/Users/Jacky-Zoë/Documents/long_extracts/"
short_extracts$ = "C:/Users/Jacky-Zoë/Documents/short_extracts/"
longer_extracts$ = "C:/Users/Jacky-Zoë/Documents/longer_extracts/"

output$ =        "C:/Users/Jacky-Zoë/Documents/All_s/"




###################################
#########################################################################
###################
soundname$ = "s"
originals$ = short_extracts$


accept_directory$ = output$ + "/"+soundname$+"/"
reject_directory$ = output$ + "/reject/"
createDirectory: accept_directory$
createDirectory: reject_directory$

accepted_table_file$ = output$+"accepted.Table"
if fileReadable (accepted_table_file$)
      accept_table=Read from file: accepted_table_file$
else
      accept_table = Create Table with column names: "accepted", 0,
"filename sound word comment"
endif

accept_length = Get number of rows

rejected_table_file$ = output$+"rejected.Table"
if fileReadable (rejected_table_file$)
      reject_table=Read from file: rejected_table_file$
else
      reject_table = Create Table with column names: "rejected", 0,
"filename sound word comment"
endif

reject_length = Get number of rows

Create Strings as file list: "fileList", originals$+"/*.wav"
number_files = Get number of strings
appendInfoLine: number_files, "files"

start_from = 1 + accept_length+ reject_length

for file from start_from to number_files
```

```
      select Strings fileList
      appendInfoLine: file
      filename$ = Get string: file
      appendInfoLine: filename$
      long_sound = Read from file: long_extracts$+filename$
      longer_sound = Read from file: longer_extracts$+filename$
      original = Read from file: originals$+filename$
      appendInfoLine: "---"
      clicked = 3
      while clicked >= 3

            if clicked = 4
                  selectObject: longer_sound
                  Play
            else
                  selectObject: original
                  Play
                  Play
                  selectObject: long_sound
                  Play
            endif
            beginPause: "save, reject or replay"
                  comment: "Please type in the word you're hearing.  If
you want to reject the sample, you can leave this field empty."

                  sentence: "word", ""
                  comment: "Comments are optional."
                  sentence: "comments", "-"
            clicked = endPause: "save", "reject", "play again","longer
sample", 0
            appendInfoLine: clicked
            writeInfoLine: word$
            appendInfoLine: comments$
      endwhile

      if clicked = 1
            Save as WAV file: accept_directory$+filename$
            selectObject: accept_table
            Append row
            last_row = Get number of rows
            Set string value: last_row, "filename", filename$
            Set string value: last_row, "sound", soundname$
            Set string value: last_row, "word", word$
            Set string value: last_row, "comment", comments$
            Save as tab-separated file: accepted_table_file$

      elsif clicked = 2
            Save as WAV file: reject_directory$+filename$
            selectObject: reject_table
            Append row
            last_row = Get number of rows
            Set string value: last_row, "filename", filename$
            Set string value: last_row, "sound", "not "+soundname$
            Set string value: last_row, "word", word$
            Set string value: last_row, "comment", comments$
            Save as tab-separated file: rejected_table_file$
```

```
      endif
      selectObject: original
      plusObject: long_sound
      plusObject: longer_sound
      Remove

endfor
```

*Get_intervals_lengths.PRAAT*

```
#########    INFO #######
#
annotations$ = "C:/Users/Jacky-Zoë/Documents/Manual_annotations_dt_L2/"
output$ =  "C:/Users/Jacky-Zoë/Documents/stats_dt/"
tier_number = 1

###################################
########################################################################
###################
out_table = Create Table with column names: "VOTs", 0, "speaker gender
recording sound VOT filename xmin xmax"


files = Create Strings as file list: "fileList", annotations$ +
"*.TextGrid"
number_of_files = Get number of strings

out_row = 1
for file from 1 to number_of_files
      selectObject: files
      filename$ = Get string: file
      raw_filename$ = left$(filename$, length(filename$)-
length(".TextGrid"))
      appendInfoLine: filename$

      annotation = Read from file: annotations$ + filename$
      number_of_intervals = Get number of intervals: tier_number
      for interval from 1 to number_of_intervals
            selectObject: annotation
            label$ = Get label of interval: tier_number, interval

            if label$ != ""
                  selectObject: annotation
                  xmin = Get start point: tier_number, interval
                  xmax = Get end point: tier_number, interval
                  length = xmax-xmin
                  selectObject: out_table
                  Append row
                  Set string value: out_row, "speaker",
left$(filename$,5)
                  Set string value: out_row, "gender", mid$(filename$,5)
                  Set string value: out_row, "recording",
mid$(filename$,6)
                  Set string value: out_row, "filename", filename$
                  Set string value: out_row, "sound", label$
                  Set numeric value: out_row, "VOT", length
                  Set numeric value: out_row, "xmin", xmin
                  Set numeric value: out_row, "xmax", xmax
                  out_row += 1

            endif

      endfor
      selectObject: annotation
      Remove
```

```
endfor

selectObject: out_table
Save as tab-separated file: output$+"/VOTs.Table"
```