The interaction between the segmental and the prosodic phonology in the midst of an on-going sound change

Resolving a contradiction in the synchronic phonology of Dutch

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At the surface level, present-day Dutch appears to suffer a contradiction between the segmental and the prosodic phonology with respect to its vowel system. On the one hand, the tense mid vowels [ei,øy,ou] are realized as diphthongs on the segmental level, but on the other hand, these vowels do not behave as diphthongs on the prosodic level, since they fail to attract stress. By revisiting the timeless tenseness-length debate in the phonology of Dutch, and arguing, on multiple independent bases, that *both* tenseness and length play a role at the underlying level – an option that was hitherto not considered – and showing that these two features are not as correlated as previously thought, my thesis attempts to unify these two observations, thus proposing a resolution to the contradiction.

1. The diphthongization of Dutch /e,ø,o/

1.1. Changes in the phonological system

A sound change that has been pervading the Dutch phonological system for almost a hundred years now is the diphthongization of the tense mid vowels /e,ø,o/. As early as in 1924, Zwaardemaker & Eijkman noted that these vowels had begun to develop a high offglide, thereby taking their first steps towards diphthongization. The vowels' journey from [eː,øː,oː] towards present-day [ei,øy,ou] is aptly discussed by Van de Velde (1996), who charts the historical development of the diphthongization over a course of 58 years (1935—1993) using radio recordings. He shows (p. 164) that the diphthongization of at least [eː] shows a near-perfect S-curve pattern, which is a classic indicator of language change in progress (Kroch 2008). Later synchronic measurements by van der Harst (2011) confirm that, segmentally, as of the twenty-first century, the tense mid vowels have indeed become genuine diphthongs, from a phonetic point of view at least. It is interesting to note that, according to Labov, Yaeger, & Steiner (1972), this phonetic change has been only natural: apparently, tense mid vowels have a tendency to diphthongize[1]. A worthwhile question to ask at this point is: how is the (phonetic) diphthongization of the Dutch tense mid vowels reflected in the contemporary native speaker's *phonology*? The interesting aspect here is that phonology is principally intangible, and hence can only be learned by new native speakers by induction (Hamann 2014). Given lexicon optimization, it would therefore stand to reason that, with the phonetics of present-day Dutch demonstrating full diphthongization of /e,ø,o/, the present day native speaker of the language would construct her mental categories for these sounds as /ei,øy,ou/, lacking any evidence to the contrary.

Before actually turning to the native speakers themselves, let's first say what phonologists have theorized about the mental representations of these sounds. The good news is that no-one has flat out denied the phonetics of the tense mid vowels' diphthongization. However, the diphthongization of /e,ø,o/ is consistently delegated to the domain of phonetic implementation, thereby escaping linguistic description (e.g. Booij 1995, van Oostendorp 2000, *inter alia*). Recent evidence, however, has suggested that the diphthongization of /e,ø,o/ might be phonological after all. Berns & Jacobs (2012), for instance, note that some speakers neutralize a tense-mid-vowel diphthong when it precedes a tautosyllabic approximant (viz. /l/), pointing towards a phonological restriction on diphthongization (to be investigated in sections 1.3 and 1.4). It is important to note that this restriction against diphthong-

[1] Cf. English [eɪ,əʊ] (the latter of which shows extreme diphthongization, with lowering of the diphthong's nucleus, cf. Labov 1994). But also take note of Flemish or German [eː,øː,oː], which have not diphthongized (yet?).

approximant sequences and its resolution of diphthong monophthongization holds for the 'true' (lax) diphthongs as well as for the tense mid vowels, which is strong evidence for a phonological recategorization of the tense mid vowels as underlying diphthongs. This phonological recategorization, discussed more extensively in the aforementioned sections 1.3 and 1.4, is, of course, based on changes in the phonetic domain. The history of these changes is what is discussed in the following section, section 1.2.

1.2. A chain shift: from monophthongs to Polder Dutch

As mentioned, the first public statement on the incipient diphthongization of Dutch /e,ø,o/ was made by Zwaardemaker & Eijkman (1924), notably in a textbook on (Standard Dutch) phonetics. As one could expect from native speakers observing change in their own language (cf. Aitchinson 1991), Zwaardemaker & Eijkman do not approve of the beginning diphthongization they observe, considering it an unsophisticated vulgarism. Importantly, they note that this diphthongization does *not* occur before /r/ or, in sloppy speech, /l/[2], which, I will claim below, is a restriction that has survived in phonologized form into present-day Dutch.

Zwaardemaker & Eijkman's noticing of the beginning diphthongization of the tense mid vowels and their disapproval thereof is shared by van Haeringen (1924, 1949). Also interesting is Blancquaert (1969), who not only notes the very same developing diphthongizations, but also admonishes Flemish speakers not to go along with this change. His wish seems to have come true, since indeed one of the most striking differences between Standard Dutch and Flemish Dutch is that Flemish Dutch did *not* start to diphthongize the tense mid vowels. According to Van de Velde (1996), it wasn't until the 1970's that the diphthongization of the tense mid vowels was accepted as being standard Dutch. At that point, it became the *monophthongs* that became stigmatized as overly pretentious or posh (Voortman 1994:70) or as indicative of a particular (e.g. southern) type of accent. Note that this is essentially a *markedness reversal*, which I will come back to in section 1.4.

At this point, Van de Velde (1996) becomes relevant once again. Van de Velde used a corpus consisting of radio recordings of both Northern-Netherlandic (i.e. the Netherlands) and Southern-Netherlandic (i.e. Flanders) speech. The recordings selected were all directed to the entire respective nation (either the Netherlands or the Dutch-speaking part of Belgium), thereby being representative for the standard language of the respective region. Recordings of various specific representative time frames were collected: for the Northern Dutch portion, the speech recordings used were made in 1935,

[2]Note how Zwaardemaker & Eijkman (1924:127) first claim that *diphthongization* is sloppy or vulgar, and then subsequentely state that it is *un*sophisticated to *monophthongize* before /l/. This seems a curious contradiction.

1950, 1965, 1980, and 1993; for Southern Dutch portion, the speech recordings originated from 1935, 1965, and 1995[3]. Van de Velde compared these recordings both synchronically and diachronically (i.e. both within-subject and between-subject comparisons were performed, with the 'subjects' being the radio recordings from any given time frame). Van de Velde's results on the diphthongization of the tense mid vowels (Van de Velde 1996:164) indicate that, in the Netherlands, diphthongization has monotonically increased from approximately 5% diphthongization in 1935 to approximately 80% diphthongization in 1995, proceeding in the already-mentioned S-curve typical of language change. In Flanders, however, there has been no such increase in diphthongization: Southern Dutch diphthongization displays a nearly completely flat line from approximately 2% diphthongization in 1935 to the same percentage in 1995. Again, it seems that Flanders has followed Blanquaert (1969)'s advice not to diphthongize the tense mid vowels.

While the tense mid vowels were beginning to diphthongize, a second change in the pronunciation of Dutch vowels had reared its head, which was first observed in 1990 (Jacobi 2009) and is extensively discussed in Stroop (1998). The diphthong /ɛi/ had begun to lower towards the position of [ai]. This sound change is widely regarded (e.g. Jacobi 2009, Stroop 1998) as being a pivotal change towards the so-called 'Polder Dutch', of which lowered diphthongs and diphthongized tense mid vowels are the defining characteristics. Stroop (1998) goes so far as to claim that the lowering of /ɛi/ is the *first* step of the vowel shift that is Polder Dutch, constituting the beginning of a drag chain. His reasoning is as follows. Due to /ɛi/ moving downward in the vowel space, a gap is left at its former location. In Stroop's view, this gap then went on to attract the tense mid vowels /e,ø,o/, which are then poised to become the new /ɛi,œy,ɑu/. However, this view is diachronically inconsistent. As noted before, diphthongization of the tense mid vowels had already been noted in 1924 (by Zwaardemaker & Eijkman), whereas the lowering of /ɛi/ is a relatively recent process, the first work on which has been Stroop's own book from 1998. It therefore seems illogical to conclude that the lowering of /ɛi/ *caused* diphthongization of the tense mid vowels. Diachronically, it would be far more reasonable to claim that the first step of the chain shift that is now known as Polder Dutch was the beginning diphthongization of the tense mid vowels. Labov, Yaeger, & Steiner (1972) have already shown that diphthongization of the tense mid vowels is a very natural tendency, which is all the more reason to assume it forms the head end, rather than the tail one, of a chain shift. If we assume that the Polder Dutch chain started with the tense mid vowels diphthongizing (as had been noted in 1924 by Zwaardemaker & Eijkman), we would state next that this diphthongization caused /eː/ ([ei]),

[3] 1950 and 1980 were excluded from the Southern Dutch dataset due to the smaller size of the Southern Dutch subcorpus.

/øː/ ([øy]), and /oː/ ([ou]) to become too similar to /ɛi/, /œy/, and /ɔu/[4], *pushing* them out of the way to their current positions of [ai], [ɒy], and [ɑu] (as noted by Stroop 1998 and Jacobi 2009).

Literature on chain shifts can be found in abundance, and in order to compare Stroop's view of Polder Dutch being a drag chain and my view of it being a push chain, I turn to Labov (1994). Labov states four principles of linguistic change, two of which are relevant here (the other two have been colored gray for the purpose of clarity):

> 'PRINCIPLE I
> **In chain shifts, long vowels rise.**
> PRINCIPLE II
> **In chain shifts, short vowels fall.**
> PRINCIPLE IIA
> **In chain shifts, the nuclei of upgliding diphthongs fall.**
> PRINCIPLE III
> **In chain shifts, back vowels move to the front.**'
>
> (Labov 1994:116, bold emphasis in original, grayening by CV)

These principles are not entirely in agreement with our data: when Labov states that 'in chain shifts, long vowels rise', he does not mean diphthongization with a high vowel but rather rising of the vowel altogether. This would have resulted in three mergers, which did not happen. If, however, we allow 'rising' to apply to only the second part of a long sound instead of the sound as a whole (i.e. upgliding diphthongization), Labov's principle I can be applied to Dutch. Labov's principle IIA, on the other hand, is immediately applicable to our data: the nuclei of Dutch /ɛi/, /œy/, and what used to be /ɔu/ have indeed fallen considerably. It is also applicable to the current, diphthongized, tense mid vowels, which, as discussed, are developing a falling tendency of their own (Stroop 1998).

Before we continue, take note that nowhere does Labov explain *why* long vowels should rise in chain shifts; similarly, though it is noted by Labov, Yaeger, & Steiner (1972) that the tense mid vowels often tend to diphthongize, this observation is also not given a *reason* for why it is often made in the first place. This is helpful to my argument that Polder Dutch is a push chain: the diphthongization of the tense mid vowels didn't happen for intrinsic linguistic reasons, but just happened. If this is so, we can proceed with the statement that, if there is diphthongization, the nucleus of the diphthong may fall. Since Dutch diphthongization is always fully upgliding (van Oostendorp 2000:78), this is in full agreement with Labov's (1994) principle IIA.

[4] Older phonological literature on Dutch transcribed /ɑu/ as /ɔu/, presumably reflecting the then-contemporary composition of the sound.

Then a push chain is not only chronologically correct, but also principally the most credible option.

1.3. Phonetic evidence for a phonological change

All diphthongizing segments – both the 'true' diphthongs and the tense mid vowels – have distributional restrictions imposed upon them. Most importantly, it is not possible for a diphthong to be followed by an approximant (Booij 1995), as shown by Berns & Jacobs (2012) for /l/ and Gussenhoven (1999) for /r/. (As of yet, no research has been done on the effects of /ʋ/ and /j/ on diphthongization, however, introspection yields that they, too, affect diphthongization.) In this section I present acoustic measurements that will turn out to support the claim that an approximant is never preceded by a diphthong that has not been — at least partially — monophthongized[5].

The hypothesis I will assume in this subsection is that Dutch diphthongs are changed into monophthongs when they precede an approximant. Since Dutch diphthongs always consist of a tense mid vowel plus the corresponding high vowel (van Oostendorp 2000:78), any diphthongization should be reflected primarily in the first formant. With this in mind, I have performed acoustic analyses on 260 word tokens of spoken Dutch, which were obtained from the Dutch teacher corpus (van Hout et al. 1999; cf. Van de Velde & van Hout 2003) and were segmentated by hand. These word tokens corresponded to 8 vowels[6] ((a), (i), (u), (o), (e), (ø), (œy), and (ɛi)), all of which were obtained from word list readings performed by native speakers from the Randstad[7] (4×5 speakers, differing with respect to gender and age[8]). The first[9] formants of these vowels were measured seven times each at equidistant time points (per van der Harst 2011), ranging from the beginning of the vowel to its end (for each vowel two words were analyzed, except in the cases of (o), (e), and (œy) for which only one word was analyzed due to time constraints). Each vowel was measured in three different types of word: a C_0_s word, a C_0_t word, and a C_0_ɫ word[10]. The measurements were first taken automatically,

[5]I am greatly indebted to Hans Van de Velde & Sander van der Harst for providing me with the opportunity to take these measurements, and they should receive most of the credit for this subsection.

[6]While, strictly speaking, only (o), (e), (ø), (œy), and (ɛi) are relevant for the hypothesis, it made sense to also include (a), (i), and (u), as these vowels make up the outer edges of the vowel triangle, allowing for easy identification of the shape of the total vowel space.

[7]This is the region of the Netherlands where the most prestigious and (therefore) 'most standard' variety of Dutch is spoken.

[8]Note that the effect of age has not been taken into consideration in these analyses.

[9]The second formant was measured and hand-corrected as well, but its analysis is not presented here due to the F2 having no bearing on the hypothesis.

[10]The exact words used were: 'aas', 'staat', 'kies', 'riet', 'poes', 'voet', 'boos', 'boot', 'mees', 'beet', 'neus', 'neut', 'huis', 'fluit', 'ijs', 'spijt', 'beul', 'geil', 'geul', 'heil', 'hiel', 'keel', 'sjaal', 'stoel', 'uil', 'wiel', 'zaal', 'zool', and 'zwoel'.

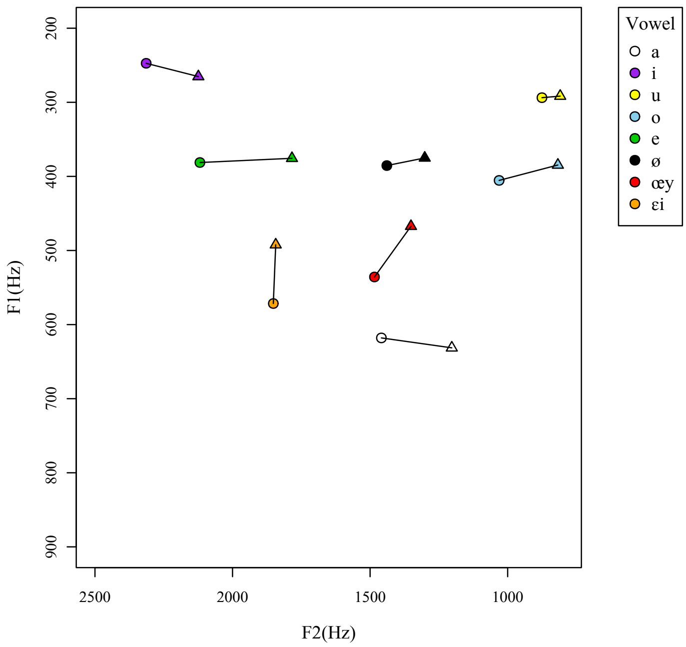


Figure 1: F1 track of the vowels measured in /l/ contexts. For each vowel the first measurement (at 25% realization) is indicated by a circle, the last measurement (at 75% realization) is indicated by a triangle.

and any outliers were corrected by re-measuring them manually. For the /l/ contexts, a vowel space plot has been made which I have reproduced as figure 1; this plot is to be compared to figures 2 and 3, which show these same vowels in C_0_s and C_0_t contexts (based on the data used in van der Harst 2011). The F1 values are also included in the appendix, both in graphical form showing their development over time (figures 7, 8, and 9) and in tabular form (table 5; the F2 values are also included in tabular form as table 6).

The measurements at time points 25%, 50%, and 75%[11] were analyzed by means of a repeated-measures ANOVA with TIME, CONTEXT, and the interaction TIME×CONTEXT as within-subject factors and GENDER as a between-

[11]The analysis was limited to these three time points for two reasons:

- The first and final time points were heavily influenced by coarticulation (they have, consequently, also been excluded from the plots in figures 7, 8, and 9);
- The other intermediate time points were left out of the analysis to prevent the procedure from becoming too involved. (van der Harst 2011 did not analyze these time points either.)

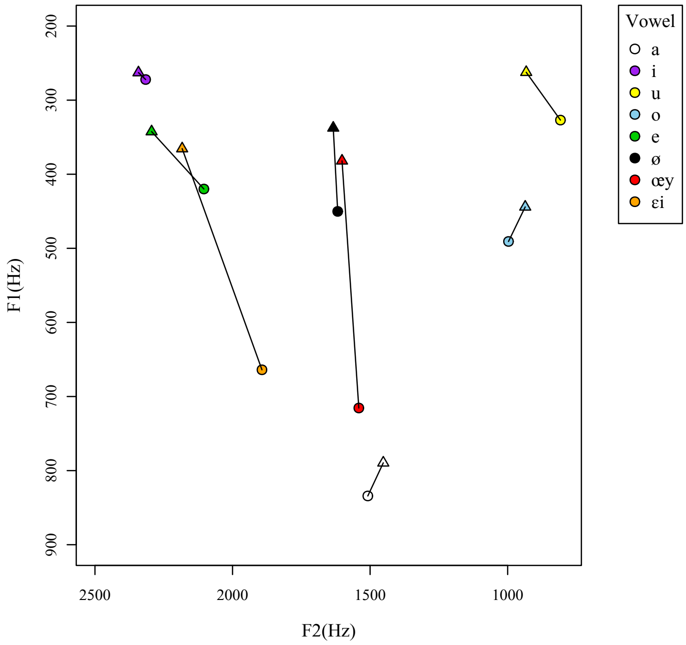


Figure 2: F1 track of the vowels measured in /s/ contexts. For each vowel the first measurement (at 25% realization) is indicated by a circle, the last measurement (at 75% realization) is indicated by a triangle.

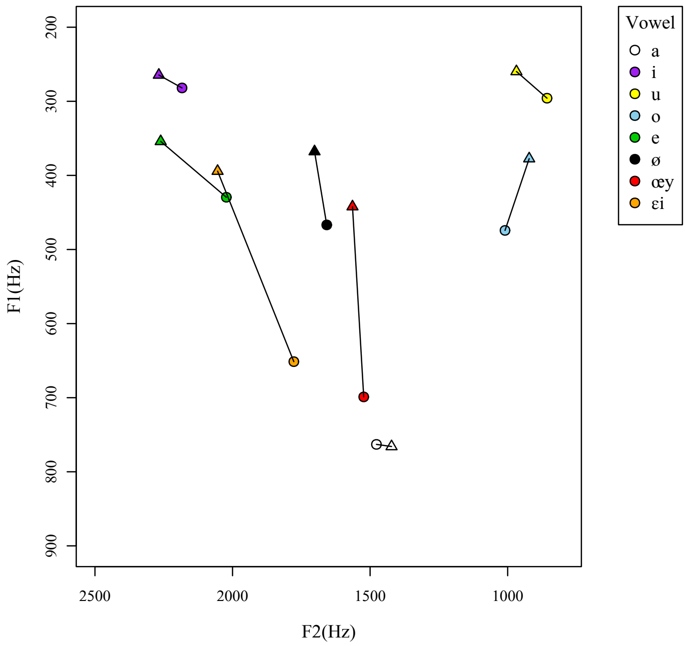


Figure 3: F1 track of the vowels measured in /t/ contexts. For each vowel the first measurement (at 25% realization) is indicated by a circle, the last measurement (at 75% realization) is indicated by a triangle.

Table 1: Huynh-Feldt-corrected p-values obtained by means of repeated-measures ANOVA performed on the F1 values measured on the 25%, 50%, and 75% intervals. The columns show the factors used in the analysis. The analyses per context were performed by executing three repeated-measures ANOVAs on each context and manually applying the Bonferroni correction.

vowel	TIME	CONTEXT	TIME × CONTEXT	**analyses per context** /s/	/t/	/l/
(a)	0.000	0.163	0.173	0.042	0.046	0.309
(i)	0.123	0.616	0.001	0.197	0.115	0.001
(u)	0.012	0.000	0.000	0.000	0.000	0.317
(o)	0.000	0.000	0.000	0.000	0.000	0.390
(e)	0.121	0.000	0.000	0.000	0.000	0.655
(ø)	0.003	0.000	0.000	0.000	0.000	0.076
(œy)	0.026	0.000	0.000	0.000	0.000	0.024
(εi)	0.618	0.000	0.000	0.000	0.000	0.000

subject factor. The effects of GENDER will not be reported here, since the effects of gender on the formant space are already well-known (cf. e.g. van der Harst 2011) and have no real bearing on the hypothesis. There were a few interactions between GENDER and any one of the within-subject factors, but these seemed to be sporadic in nature and did not change the overall picture. (The exact interactions can be found in the appendix, where they have been included as table 4.)

After performing the repeated-measures procedure, for each vowel individual analyses were performed on the interaction TIME×CONTEXT[12] by running three separate repeated-measures ANOVAs on each context and subsequently manually applying the Bonferroni correction for repeated tests (i.e. the effective significance level adopted was not 0.05, but rather 0.0166 ($\frac{1}{3} \times 0.05$)). The results are summarized in table 1.

The vowels (o), (e), (ø), and (œy) all behave exactly as expected by our hypothesis: they exhibit a significant TIME×CONTEXT interaction effect, and post-hoc tests for effect are significant for the /s/ and /t/ contexts (i.e. the C_0_s and C_0_t words), but *not* for the /l/ contexts (i.e. the C_0_ɫ words) ($p < 0.0166$ for /s/ and /t/; *n.s.* for /l/). This means that the vowels changed

[12]Since our hypothesis concerned the effect of context (CONTEXT) on diphthongization (which was represented by the factor TIME), only this interaction was of real interest to us.

over time (i.e. diphthongized) in the /s/ and /t/ contexts, but remained constant in the /l/ contexts, as per the hypothesis. Curiously, /ɛi/ did *not* appear to monophthongize when followed by /l/ ($p < 0.0166$), even though when looking at the plot on page 47 it appears to diphthongize no more than (œy) does, which *did* monophthongize (its post-hoc test was non-significant in the /l/ context). Consequently, it seems fair to state that it looks like the phonological process of MONOPHTHONGIZATION (to be worked out in section 1.4) allows for a phonetic implementation as not only *complete* reduction of diphthongization, but also *partial* monophthongization. The fact that (ɛi) and (œy) have different p-values, while appearing to exhibit comparable behavior in the plots, demonstrates that there is, evidently, some leeway in exactly how *fully* a diphthong must monophthongize in the /l/ context.

The vowels for which no diphthongal allophone exists, i.e. the high vowels and (a), show less clear patterns. While (a), expectedly, does not show any difference in either context (its F ratio was non-significant), (i) shows the curious pattern of remaining constant in the /s/ and /t/ contexts, but changing in the /l/ context! This is also observed implicitly by van der Harst (2011), who notes that 'the vowel's height was most affected by the following alveolar consonants for the vowels that share the place of articulation with these consonants [/s/ and /t/, CV], i.e. that are high and front' (van der Harst 2011:160). With [ɫ] beginning to vocalize (van Reenen & Jongkind 2000), becoming phonetically similar to [ɔ] (Sander van der Harst, *p.c.*), which is, crucially, not a front vowel, this could offer a plausible explanation for (i)'s behavior: it predicts, correctly, that in the phonetically $\begin{bmatrix}\text{+high}\\ \text{-back}\end{bmatrix}$ contexts (i.e. [s] and [t]), we should expect a different (i) than in the phonetically $\begin{bmatrix}\text{-high}\\ \text{+back}\end{bmatrix}$ context (i.e. an [ɔ]-like [ɫ]). Thus, the behavior of (i) seems to be explicable by means of phonetics, rather than phonology.

The diphthong-like behavior of (u) can also be explained via van der Harst (2011), who found 'community-independent instability of /u/' (van der Harst 2011:190). In other words, according to van der Harst, /u/ appears to have diphthong-like characteristics. And this indeed is exactly what the results would seem to show: that the vowel is unsteady in the /s/ and /t/ contexts, while it stabilizes in the /l/ context, which is exactly how I hypothesized diphthongs to behave. Thus, it looks like this is a process that takes place at the very edges of both phonetics and phonology: while (u) is phonologically monophthongal (because it's short, and because it patterns with the high vowels instead of the diphthongs), its *phonetic* behavior (which is that of a diphthong) nevertheless looks to be bound by the phonological constraint against diphthong-approximant sequences.

As a visual aid, it is instructive to review the plot of the measurements shown in figure 1. Certainly, it can be seen at a glance that there is a marked reduction in diphthongization in the /l/ context, especially when compared to the same plots for /s/ and /t/ in figures 2 and 3. This seems to point in the direction that I am right in claiming, as I will indeed in section 1.4, that there is indeed a *phonological* process exerting a (phonetically non-absolute) monophthongization upon *any* diphthong preceding, among others, /l/.

1.4. From phonological change to (still-ongoing) phonemic change

Up to now, I have argued that Dutch has been undergoing a change for the past century or so whereby the tense mid vowels have become diphthongs when not preceding /l/. Before continuing this line of reasoning towards what we as phonologists must ultimately describe — the knowledge of the present-day native speaker —, it should be noted that this story is not entirely as tightly-fitting as the reader may up to now believe. The formant measurements shown in section 1.3 were generalizations across a highly diverse group of people (both Northern- and Southern-Netherlandic, from any province in either country). When turning to individual speakers, as Berns & Jacobs (2012) did in their three-speaker study, it becomes easier to see exactly how murky the situation surrounding the pre-/l/ tense vowels really is. What their data showed was that all three speakers, who normally diphthongized their tense mid vowels, in some way altered their diphthongs when they preceded a coda /l/, but the exact difference from their 'elsewhere' allophones was highly variable between the three speakers (though stable within them). For example, one speaker monophthongized their tense mid diphthongs exactly as described in section 1.3, whereas another opted not for monophthongization, but for tense-lax neutralization (whilst retaining the length of the original diphthong; cf. van der Torre 2003), which is a unique option for the tense mid vowels and would hence not necessarily indicate a category change to that of diphthongs. What this shows is that, while the phonetics of [ei,øy,ou] are unambiguous (these vowels are clearly diphthongs, at least in the prototypical segmental context), these vowels' phonology is highly *variable* (we will discuss a specifically problematic example in section 2).

The thus distinctly murky position of /e,ø,o/ in the phonological system of present-day Dutch is perfectly explicable when it is considered in its proper context; recall that the diphthongization of the tense mid vowels is a facet of a sound change in progress (in fact, per section 1.2, it is the very same change that has been dubbed 'Polder Dutch' by Stroop 1998). Phonological instability during a sound change in progress is, in fact, wholly predicted by a theory such as Hyman's (1976) four-stage model of phonological change. Briefly put, Hyman's (1976) idea is that phonological change starts out in the domain of phonetics, in that what Hyman calls 'intrinsic variation' (any innocent byproduct of the realization of a phone by the human vocal tract, usually reflecting a natural tendency[13]) is mistaken for 'extrinsic variation' (i.e. phonologically programmed variation). In other words, in Hyman's model, sound change starts out as an innocent single instance of phonological reanalysis: an irrelevant phonetic feature is, by mistake, taken to be relevant; the listener thus fails to compensate for a certain type of phonetic distortion caused by the human vocal tract (cf. Ohala 1981). At this point, the listener has a deviant phonological (but not yet *phonemic*) representation; at some point she may reanalyze further, and upgrade the initially intrinsic variation to extrinsic status, a process which Hyman calls 'phonemicization'. Finally, this newly-extrinsic property might drive out the *formerly*-extrinsic property, causing this initial cue to be lost altogether.

Before showing how this small sketch of Hyman's proposal can explain the variability that was found by, e.g., Berns & Jacobs (2012), it seems merciful to make Hyman's points a bit more concrete by relating them to the on-going diphthongization of Dutch /e,ø,o/. In the previous paragraph, I showed how Hyman distinguished three processes in the lifecycle of phonological change: phonologization, phonemicization, and loss of the initial contrast. For the Dutch tense mid vowels, this would mean the following. At some point not too far before 1924 (Zwaardemaker & Eijkman's noticing of the beginning diphthongization of the tense mid vowels), a group of Dutch speakers started to mistakenly attribute the upgliding diphthongization in these vowels as regulated by the phonology, rather than being the innocent byproduct of Labov, Yaeger, & Steiner's (1972) natural tendency to diphthongize these vowels phonetically. One could represent this state of affairs as such (where, for convenience, I will use a feature [+diphthong] to refer to a bimoraic diphthong and [-diphthong] to refer to a bimoraic monophthong):

	Old phonology:		New phonology:
(1)	/e,ø,o/	$\Rightarrow$	$\begin{bmatrix}\text{+tense}\\ \text{-high}\\ \text{-low}\end{bmatrix} \rightarrow$ [+diphthong]

The next year of importance is ±1970 — the year noted by Voortman (1994) to have hallmarked the standardization of the diphthongal pronunciation of /e,ø,o/. From approximately this year forward, all new language learners are exposed to diphthongal realizations of the tense mid vowels. It should only be a matter of time, then, before at least one of them decides that these — as of now — tense diphthongs should behave the same as the already long-established lax diphthongs, i.e. that these two phonological categories should merge:

[13] At this point, please recall that Labov, Yaeger, & Steiner (1972) considered diphthongization of tense mid vowels to be a highly natural development.

	Old phonology:		New phonology:
(2)	$\begin{bmatrix}\text{+tense}\\ \text{-high}\\ \text{-low}\end{bmatrix} \rightarrow [\text{+diphthong}]$	$\Rightarrow$	/ei,øy,ou/

This is what Hyman would call ‘phonemicization’: the sound change has entrenched itself not at the phonological-rule level, but rather at the phoneme level. At this point, what Hyman terms ‘rule inversion’ takes place, which is in fact a markedness reversal (in fact, this is the very same markedness reversal that we discussed in section 1.2!). That is, the rule ‘*original forms* → [+diphthong]’ is replaced by a rule ‘[+diphthong] → *original forms*’, i.e. the *diachronic* rule of DIPHTHONGIZATION has become replaced by a *synchronic* rule of MONOPHTHONGIZATION, which obviously entails a swapping of the synchronic underlying forms. This rule inversion means that the diphthongization of the tense mid vowels has become phonemic, rather than simply phonetic or phonological. This automatically predicts — correctly so — that the as-of-now tense diphthongs should display the same allophone patterns as the lax diphthongs do. That is, due to Dutch having a constraint disallowing diphthongs from being followed by approximants within the same foot, the moment the diphthongization of the tense mid vowels became phonemic (hence leading to rule inversion), it also automatically became blocked in that context. (In a sense, then, the term ‘rule inversion’ does not accurately cover the reanalysis in its entirety, given that the process also involved the genesis of a prohibitory context; for this reason, I will refer to this specific reanalysis exclusively as ‘phonemicization’, since that term more accurately captures what has truly happened.)

One important consequence of the above is that the feature [±tense] has — necessarily — taken a step backward over the course of the sound change. Before the rule inversion, the rule governing the realization of then-underlying /eː/ read ‘tense monophthongs acquire a feature [+diphthong]’. When inverted, however, this rule — ‘tense diphthongs should become monophthongs’ — is self-destructive (cf. Hyman 1976): a rule monophthongizing diphthongs was already present in Dutch anyway, so the tense diphthongs need not subject themselves to a specific rule ‘$\begin{bmatrix}\text{+tense}\\ \text{+diphthong}\end{bmatrix} \rightarrow [\text{-diphthong}]$’, but can rather tag along with the rule that already existed, i.e. MONOPHTHONGIZATION[†]: $[\text{+diphthong}] \rightarrow [\text{-diphthong}] \;/\; \overbrace{\_\quad [\text{+approx}]}^{F}$.

Note that the above automatically implies that — for those speakers who have fully completed this sound change — the monophthongized realizations of /ei,øy,ou/ are long, tense monophthongs [eː,øː,oː]. This is not, however, what all studies find. Van der Torre (2003), for instance, finds that some speakers produce long, *lax* monophthongs [ɪː,ʏː,ɔː] in the monophthongization environment. Botma, Sebregts, & Smakman (2012), however, argue that this is not possible; they postulate a phonotactic constraint prohibiting length retention when preceding a coda approximant. Then again, Berns & Jacobs (2012) show that this claim is evidently incorrect: in their three-speaker study, one of the three speakers indeed produced the long lax monophthongs suggested by van der Torre (2003). The other two speakers, however, both produced different patterns still, and in fact, only one of them exhibited behavior consistent with my own claim, viz. that the 'correct' reparation of an illicit diphthong-approximant sequence should be a *tense* long vowel. Thus, it should not be underestimated exactly how wide the *variability* in repair strategies employed actually is (as Botma, Sebregts, & Smakman did when they concluded that van der Torre's transcription practices were in error, rather than realizing he had simply found a different variant of the pre-/l/ allophones). I will now propose that the conflicting findings can all be attributed to the variable state of the feature [±tense].

The key observation is situated within the applicability of the MONOPHTHONGIZATION rule to the *lax* diphthongs /ɛi,œy,ɑu/. For these diphthongs, the neutralized allophones (those preceding a coda approximant) are, indisputably, [ɛː,œː,ɑː]. This, in fact, was the key reason for formulating MONOPHTHONGIZATION as it currently is: [+diphthong] → [-diphthong], crucially making no reference to the feature [±tense]. As a consequence, after the phonemicization of /ei,øy,ou/ had been completed and the inverted rule had merged with MONOPHTHONGIZATION, there was no more reason to reference the feature [±tense] anymore as part of the monophthongization process. In other words: due to the merging of the inverted rule with the pre-existing MONOPHTHONGIZATION rule, the feature [±tense] was *lost* from the phonological specification of the rule regulating the allophone patterns of the tense mid vowels.

What we are faced with, then, turns out to be far more than a simple change in pronunciation. What is truly taking place here is not merely a change in surface realizations, but also a change in the phonological feature specifications: [±tense] is no longer actively referenced, having been replaced by the feature [±diphthong] at the moment of the phonemicization of /ei,øy,ou/, exactly in line with Hyman's (1976) final step of 'loss' (of the original contrast). The true nature of the diphthongization of the tense mid vowels is thus a change in the *phonological feature system*: in essence, the feature [±tense] is slowly beginning to be overtaken by the new feature [±diphthong]. From this single observation on the nature of the sound change in progress, all three of the different attested repair strategies for diphthong-approximant sequences, in addition to some intermediary-stage nonattested ones, in Berns & Jacobs's (2012) study can be explained:

- Speakers who repair their phonotactically disallowed tense diphthongs by substituting long monophthongs for them are fully innovative, adopting the representations based on the feature [±diphthong]. Their phonology prescribes that monophthongization involve a rule of the type '[+diphthong] $\rightarrow$ [-diphthong]'.

- Speakers who repair their phonotactically disallowed tense diphthongs by substituting long lax vowels for them are partially innovative. Their rule employs both the (deprecating) feature [±tense] and the innovative feature [±diphthong] and is of the type '[+diphthong] $\rightarrow$ $\begin{bmatrix}\text{-tense}\\ \text{-diphthong}\end{bmatrix}$'[14].

- Speakers who repair their phonotactically disallowed tense diphthongs by substituting short lax vowels for them are even less innovative. Their rule employs both the (deprecating) feature [±tense] and the innovative feature [±diphthong] and is of the type '[+diphthong] $\rightarrow$ [-tense]', deleting the feature node for [±diphthong] from the representation entirely[15], thereby (correctly, for them) eliminating length.

- Speakers who do not feel the need to repair tense diphthongs in a (for others) phonotactically illegal context whatsoever have only barely innovated their phonology. They have not phonemicized the change, but have only phonologized it, which leaves them at the previously discussed stage of '$\begin{bmatrix}\text{+tense}\\ \text{-high}\\ \text{-low}\end{bmatrix}$ $\rightarrow$ [+diphthong]'.

- Finally, speakers who do not diphthongize their tense mid vowels in the first place have remained stuck in the pre-change state; not only have they not phonemicized the sound change, they have also not phonologized it, in essence lacking the change altogether, barring perhaps Labov, Yaeger, & Steiner's (1972) phonetic tendency to very slightly diphthongize these vowels in no particular context.

It thus ultimately turns out that the diphthongization of the Dutch tense mid vowels is, for the most crucial part, a change in the phonological *feature* system, rather than a change in merely the pronunciation or the phonemic representation. This explains the massive variability in segmental realizations of these vowels. A curious complication, however, which will be the focus of section 2, is that there is one area of the phonology of Dutch to which even the most innovative speakers have not progressed yet. When we move up into the prosodic hierarchy from segments to syllables and feet,

[14] A specification of [-diphthong] makes a long monophthong.

[15] By necessity, I assume that the feature [±diphthong] is completely deleted in this case. This could be achieved formally by having the feature [±diphthong] be located below a specification of [+tense] in a feature-geometrical configuration, for these speakers.

the tense diphthongs still appear to be parsed as heading *light* syllables as far as the Dutch footing algorithm (i.e. PARSE(σ)) is concerned. We are thus faced with a critical contradiction. On the one hand, the segmental phonology is showing clear indications that the feature [±tense] is beginning to be obsoleted by the feature [±diphthong]. On the other hand, the prosodic phonology is the complete and utter contradiction of this observation, showing none of the signs of deprecating the feature [±tense], nor any of the signs of accepting the feature [±diphthong] for the tense mid vowels (since these do not (yet) attract stress, whereas the lax diphthongs irrefutably do).

We are thus faced with two diametrically opposing and, furthermore, mutually exclusive points of view on the nature of the phonological system. The segmental phonology unequivocally prescribes diphthongal (and therefore bimoraic) phonemes for the tense mid vowels, whereas the prosodic phonology would appear to — equally unequivocally — prescribe monomoraic phonemes for the very same sounds. In what remains, we will take a closer look at the stress system of Dutch to try to solve this bizarre contradiction. At a first glance, such an enterprise might appear to be extremely infeasible due to the *complete* contradiction of these two sources of evidence. Note, however, that we *know* that a synchronically consistent description is possible: if it were not, the language-learning child, wholly innocent of the history of its own language and fully reliant on the synchronic input it is provided with (Fischer, Koopman, van Kemenade, & van der Wurff 2000), would not be able to learn the language, in which case the present problem would never have been able to exist in the first place! But with the two sources of evidence being so unyieldingly opposed to one another, the only way in which a synchronic representation of the present state of affairs seems to be achievable would be to 'cheat' and modify the theory on which one of the two types of evidence is based. Given that we have just critically updated the segmental phonology of Dutch, the remainder of this thesis will attempt to provide the same for the metrical phonology: a reinterpretation of the facts that is compatible with underlyingly diphthongal representations for the tense mid vowels.

1.5. Towards a synchronic analysis of diachronic change in progress

The goal of the remainder of this paper is to provide a synchronic analysis of the present-day state of Dutch vowel quality and metrical stress. This means, of course, that at least two types of facts on the present-day state of the Dutch phonological system will need to be made known. The stress-related data I delegate to section 2, since that is where they will be discussed, but the phonetic facts on vowel quality will be discussed here, as they will be interwoven with the entire paper.

The key observation up to now, which led to the genesis of the problem discussed in this thesis in the first place, has been the diphthongization of the tense mid vowels, which can be shown to be phonemic (in Hyman's 1976 terminology) rather than phonetic. Consider, for instance, the following pairs of words, which I will transcribe according to the phonology attested in the most innovative group of speakers (since it is this most innovative phonological system that is the subject of this paper), that is the group that monophthongizes their tense diphthongs (when preceding an approximant within the same foot) without laxing the vowel:

(3)	[ɣɛit] ⟨geit⟩ 'goat'	(6)	[ɣɛːɫ] ⟨geil⟩ 'horny'	(9)	[meit] ⟨meet⟩ 'measure'	(12)	[meːɫ] ⟨meel⟩ 'starch'
(4)	[bœys] ⟨buis⟩ 'pipe'	(7)	[bœːɫ] ⟨buil⟩ 'bump'	(10)	[ɣøys] ⟨geus⟩ 'Geus'	(13)	[ɣøːɫ] ⟨geul⟩ 'trench'
(5)	[pɑus] ⟨paus⟩ 'pope'	(8)	[pɑːɫ] ⟨Paul⟩ 'Paul'	(11)	[pout] ⟨poot⟩ 'paw'	(14)	[poːɫ] ⟨pool⟩ 'pole'

The critical observation that should be gleaned from the above data is that the (lax) diphthongs (6–8) and the tense mid vowels (12–14) follow the exact same allophone distribution, and must hence share the same phonological category. The phonological rule behind the allophony can be captured by the already discussed rule of MONOPHTHONGIZATION from the previous section, repeated below as (15) ([+diphthong] encoding the diphthongal allophone and [-diphthong] encoding the monophthongal allophone), but this is only possible when allowing the diphthongal allophone to be the underlying form. And since this neutralization pattern is identical for both the 'true' diphthongs and the tense mid vowels, this must mean that the tense mid vowels are underlyingly diphthongal as well and hence belong to the same category as the 'true' diphthongs.

(15) [+diphthong] → [-diphthong] / [F _ [+approx]]

Note that, as discussed in section 1.1, there is variation in the extent and type of diphthong neutralization employed by different speakers of present-day Dutch. This is, of course, due to the fact that the sound change in question is still in progress. For purposes of this paper, I will assume that, phonologically speaking, the majority of the population is on the far innovative end of the change, i.e. behaves according to the [+diphthong]→[-diphthong] neutralization rule I offered in (15). (If it makes a difference, this is what I myself do as well in my own speech.)

Having discussed the tense mid vowels (or 'tense diphthongs'), at least two questions should be open at this point. The first concerns the status of /a/, and the second concerns that of the lax diphthongs /ɛi,œy,ɑu/. I will treat these matters in order.

Let me start out by saying that /aː/ never diphthongizes; the sound change that is the diphthongization of the Dutch tense vowels has remained constrained to the tense *mid* vowels, of which Labov, Yaeger, & Steiner (1972) had already claimed that diphthongization is natural. There is no phoneme /ai/, nor is there any indication that there is ever going to be one at this point; the only [ai] that is found in the language is a lowered pronunciation of the phoneme /ɛi/[16] (which might eventually develop into underlying /ai/, just as historical /*ɔu/ changed into present-day /ɒu/, but, per the above, this is not relevant in present-day Dutch at the moment). Let us propose for now to reflect /a/'s consistently monophthongal realization by having it consistently be [-diphthong]. This means that there exists no Dutch segment that is underlyingly $\begin{bmatrix}\text{+low}\\ \text{+diphthong}\end{bmatrix}$.

Turning to the lax diphthongs /ɛi,œy,ɑu/, a unique property that the lax diphthongs have and the tense diphthongs do not (which is highly relevant to section 2) is that the lax diphthongs attract stress (as is expected in a quantity-sensitive language), whereas the tense diphthongs curiously do not. This issue will be explored in section 2. Another discrepancy between the lax diphthongs and the tense diphthongs is in the phonological status of the sound change that is discussed in this paper. In section 1.2 I argued that the diphthongization of tense /e,ø,o/ (first reported in 1924 by Zwaardemaker & Eijkman) gave rise to a push chain, which I argued constituted the beginning of the infamous 'Polder Dutch' vowel shift first reported by Stroop (1998), whereby /ɛi,œy,*ɔu/ had their nuclei lowered so as to become realized as [ai,ɒu,ɑu]. It is noteworthy in this respect that, while tense diphthongized [ei,øy,ou] have (by the vast majority of speakers which are the focus of this paper) been reanalyzed as reflecting underlying /ei,øy,ou/, the Polder Dutch innovations in the lax diphthongs have only partially been, as can be seen from the examples below:

[16] I am assuming here that a word like 'haiku' (id.) contains a vowel-glide sequence [ɑj] rather than a diphthong [ɑi] or [ai].

(16) [ɣait]
⟨geit⟩
'goat'

(17) [bɒys]
⟨buis⟩
'pipe'

(18) [pɑus]
⟨paus⟩
'pope'

(19) [ɣɛːɬ] (*[ɣaːɬ])
⟨geil⟩
'horny'

(20) [bœːɬ] (*[bɒːɬ])
⟨buil⟩
'bump'

(21) [pɑːɬ]
⟨Paul⟩
'Paul'

Note first of all that these examples are in direct contradiction of examples (3–5), where I transcribed [ai] and [ɒy] as [ɛi] and [œy], respectively. This is entirely deliberate, and is in fact exactly the point I want to make here. The point is that the pronunciations [ai] and [ɒy] have *not* triggered reanalysis of the underlying phoneme to /ai/ and /ɒy/, respectively. This can be seen from the diphthongs' monophthongal alternants, which are conservative [ɛː] and [œː], rather than innovative *[aː] and *[ɒː]. This means that the lowered, 'Polder Dutch' pronunciations of these vowels cannot be ascribed to an *underlying representation* in which the Polder Dutch lowering has been phonemicized; in other words, unlike the diphthongization of the tense mid vowels, the lowering of the lax diphthongs has not phonemicized (yet), but only phonologized (an observation which suggests that the former must have preceded the latter, hence again making Polder Dutch a push chain, *contra* Stroop 1998). Note that, interestingly, this does *not* appear to be the case for historical /*ɔu/, which nowadays alternates with innovative [ɑː] rather than conservative *[ɔː]. An explanation for the aberrant behavior of this final diphthong is plausibly offered by analogy: there is only one word in the entire language in which historical /*ɔu/ would have needed to monophthongize (it is the proper name 'Paul' /*pɔul/), and hence once the diphthongal pronunciation of this diphthong had lowered (as is happening phonetically to /ɛi/ and /œy/ right now), analogical levelling could swiftly cause [*pɔːɬ] to become [pɑːɬ]. Reanalysis of the segment as /ɑu/ was inevitable, then, since the [*ɔ] in this one word would have been the last remaining evidence in favor of an underlying representation of /ɔu/ as opposed to /ɑu/. But for the moment, this reanalysis has only taken place for this one diphthong, leaving /ɛi/ and /œy/ phonologically intact, for now. Note, finally, that the above pieces of evidence clearly point to a system undergoing change. Variability (mostly regional) in the exact pronunciation of the diphthongs in Dutch is the norm rather than the exception, even more so for the lax diphthongs than for the tense ones, which are pretty stably divided geographically (cf. Goossens, Taeldeman, & Verleyen 2000). The data for the lax diphthongs show most clearly of all that a sound change in progress is slowly upheaving the Dutch vowel system; the wealth of variability in the pronunciations of these vowels is nothing short of expected, then.

As a future memory aid, please consult the feature chart in table 2 and the vowel diagram in figure 4 for a concise overview of our final synchronic representation of the facts of Dutch.

	high	low	back	round	diphthong	*length*	tense
/i/	+	-	-	-		μ	-
/y/	+	-	-	+		μ	-
/u/	+	-	+	+		μ	-
/ɪ/	-	-	-	-		μ	+
/ʏ/	-	-	-	+		μ	+
/ɔ/	-	-	+	+		μ	+
/ɒ/	-	+	+	+		μ	+
/ɛ/	+	-	-	-		μ	+
/ə/	-	-	-	-		μ	-
/ei/	-	-	-	-	+	μμ	-
/øy/	-	-	-	+	+	μμ	-
/ou/	-	-	+	+	+	μμ	-
/ɛi/	-	+	-	-	+	μμ	+
/œy/	-	-	-	+	+	μμ	+
/ɑu/	-	-	+	-	+	μμ	+
/aː/	-	+	-	-	-	μμ	-

Table 2: Feature content of the Dutch vowels.

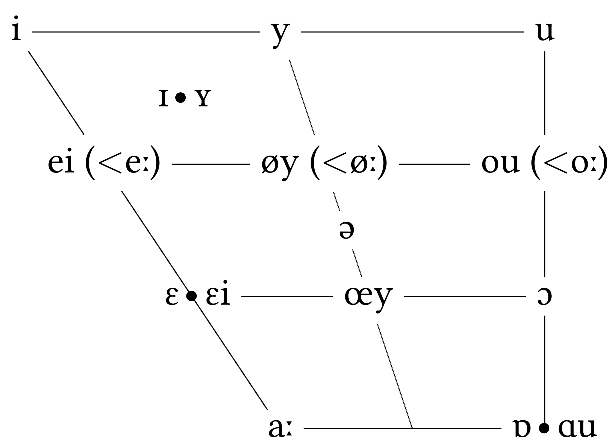


Figure 4: The present-day-Dutch vowel space, with the standard (conservative) analysis in parentheses next to the currently actual (novel) forms.

2. The metrical phonology of Dutch

2.1. The extreme markedness of Dutch quantity-sensitivity

Three representative[17] examples of the Dutch stress system are the following:

(22) [ɒn.(dɛ́i).vi]
⟨andijvie⟩
'endive'

(23) [a.(ɣɛ́n).da]
⟨agenda⟩
'agenda'

(24) [mou.(ná:.kou)]
⟨Monaco⟩
'Monaco'

The Dutch stress system has traditionally been described as using right-to-left moraic trochees (Lahiri & Koreman 1988), which crucially means that it is quantity-sensitive. The exact placement of main stress is not a straightforward matter, but Kager (1989) — among others — suggests that it is confined to a three-syllable window at the right edge of the prosodic word. The words in (22) and (23) showcase that Dutch is indeed quantity-sensitive (because in (22), stress conveniently falls on the *diphthongal* vowel of this three-syllable window) and employs weight-by-position (because in (23), the closed syllable [ɣɛn] constitutes a single foot, which must then be bimoraic).

[17] Of course, three examples can never be fully representative for the entire spectrum of metrical variation within a whole language. These three examples are intended and constructed to reflect what I claim are the three basic types of Dutch stress pattern:

(22): stress attraction by a monosyllabic diphthong, demonstrating quantity-sensitivity (note that, although the generally accepted Dutch footing algorithm works using right-to-left moraic trochees (Lahiri & Koreman 1988), [ɒn] is not footed due to *CLASH avoidance);

(23): stress attraction by a VC sequence, demonstrating weight-by-position (note that, contrary to what will be assumed below, the vowel [a] is actually tense and short in this specific example. A proper discussion of this phenomenon is deferred to section 2.5; for purposes of the theory to-be-developed, one should assume for now that this vowel is actually long — a technically incorrect position which will be rectified and integrated into the theory in section 2.5);

(24): the truly exceptional case to be studied, where long tense vowels are shown to behave as light vowels (which can actually also be inferred from (23)).

Having observed that Dutch stress is quantity-sensitive, it should come as a great surprise that the word in (24) appears to be parsed quantity-*in*-sensitively. That is, the long vowels [aː] and [ou] appear to be parsed into a single foot, which violates at least two constraints that are otherwise actively obeyed: FᴛBɪɴ(μ) (i.e. the constraint demanding feet comprise exactly two moras) and WSP (i.e. the Weight-to-Stress Principle; for both cf. (22), where the final syllable is left unparsed rather than being adjoined to the preceding foot and where the heavy diphthong clearly attracts stress).

Put a bit more abstractly, the (well-known, e.g. Hayes 1995, Kager 1989, *inter alia*) problem could be stated as follows:

(25) Dutch quantity-sensitivity appears to be *selective*:

- surface VC syllables are heavy;
- surface $\begin{bmatrix}\text{VV}\\ \text{-tense}\end{bmatrix}$ syllables (i.e. lax diphthongs) are heavy;
- surface $\begin{bmatrix}\text{VV}\\ \text{+tense}\end{bmatrix}$ syllables (i.e. long vowels) are treated as *light*!

This section on the stress system of Dutch aims to discuss the analysis that has been traditionally used to deal with the odd quantity-sensitivity system of Dutch (section 2.2) and to show the shortcomings that this analysis has (sections 2.3 and 2.4).

2.2. The standard analysis: long vowels are secretly light

The standard approach to the highly marked situation in Dutch is to assume that long vowels which are treated as light actually *are* light (van Oostendorp 2000, Gussenhoven 2009, *inter alia*). Under this analysis, the structure of a word like (24) is actually as in (26), with three monomoraic syllables:

(26) mo.(ná.ko)

This analysis implicitly takes a stance in a decades-old issue in Dutch phonology that is commonly known as the tenseness-length debate. The academic question is as follows: are long vowels underlyingly specified as long with their tenseness being assigned phonologically, or are these vowels underlyingly tense and does Dutch have a phonological rule lengthening tense vowels? In attempting to solve the conundrum of Dutch quantity-sensitivity, the presently-accepted view (cf. Gussenhoven 2009) takes a stance on this related debate: it explicitly assumes that the vowels are underlyingly tense and short, and that length is assigned phonologically later on by application of, e.g., the Stress-to-Weight Principle.

This analysis has two non-obvious drawbacks. The first is that this argument creates a cyclical dependency between two principally nondependent positions in Dutch phonology. That is, while it has been argued that a tenseness-based analysis of Dutch vowel quality allows a feasible description of the bizarre Dutch quantity-sensitivity system, the exact feasibility of this analysis has also been used as an *argument* for using the feature [±tense] (over a feature like [±long]) in the first place (cf. van Oostendorp 2000)! This is obviously circular, though I should point out that this need not be a problem if the analysis turns out to be *right*.

The second drawback, which has also been overlooked in the literature but this time for more obvious reasons, is that a short- and, hence, tenseness-based analysis of Dutch quantity-sensitivity creates a mismatch between the segmental and the prosodic phonology of Dutch. That is, the categorical unity of the tense mid vowels and the lax diphthongs, with which section 1.5 ultimately concluded, can by definition not be borne out by a theory of Dutch metrical stress that insists that the two be separate. As with the previous concern, a contradiction between the segmental and the suprasegmental levels of the phonology need not be a problem if the theory predicting it turns out to be actually *right*. Another potential excuse for generating such a contradiction could be found in the fact that the diphthongization of the Dutch tense mid vowels, and hence their categorical unity with the (lax) diphthongs, is the result of a currently on-going sound change in the language. This sound change might, one could argue, be progressing through the phonological system starting from the lowest level of the phonology, and might simply not have made it to the metrical level yet. For these reasons, let us go over not only the counterarguments that I can raise, but also the arguments that have been made *in favor* of an analysis of Dutch long vowels as underlyingly short.

A powerful argument comes from Kager (1989), who notes that if we do not analyze these long vowels as being underlyingly short, Dutch would be in lack of CV syllables (assuming that the middle consonant in VCV sequences is in fact ambisyllabic, and hence closes the first V). This is a problem, since these syllables are so universally unmarked by all standards that they are attested in every other language in the world; by not having them, Dutch would be in violation of a language universal (Kager 1989). The premise of this argument, however, is not correct. What Kager (1989) seems to be forgetting about is the high vowels[18] — [i,y,u] — which are tense, but short. Following van Oostendorp (2000), tenseness theory analyzes these vowels as if they would have been lax, but were barred from being so by means of a constraint

[18]Superficially, a 'schwallable' (a C_0ə syllable; Kager 1989) also follows a C_0V structure, but Kager argues that schwa is actually completely weightless, and hence — from a metrical point of view, at least — a syllable headed by schwa is not considered a core syllable within Kager's theory.

‘*[high,lax]’ (*sic*, van Oostendorp 2000:73). Consequently, these vowels do not share the lax vowel’s requirements that they have a coda, but are short nonetheless, leading to a C_0V syllable structure after all.

Van Oostendorp (2000) provides some further arguments. Actually, the point he wants to make is not necessarily that long vowels are underlyingly short, but rather that [±tense] is the underlying feature, as opposed to [±long]. However, we have already seen that the underlyingly-short and the only-[±tense]-based analysis mutually entail one another, and hence van Oostendorp’s arguments for the latter also bear discussing here. Van Oostendorp argues that, despite the ability for a length-based analysis of Dutch vowels to correctly *require* lax vowels, and only lax vowels, to have codas (a matter which is tangential to our needs for the moment), a length-based analysis faces multiple problems. His first argument for this position is exactly the point made by Kager (1989) — long vowels being actually short from a metrical point of view — and is still just a circular extension of his own argument that we need a feature [±tense]. Since I do not see the point in using the question itself to motivate a potential answer to it, this argument is left undiscussed: in the current context, it is circular. Van Oostendorp’s second argument is again the same as an argument by Kager (1989) that we have already seen, namely the fact that Dutch would supposedly not have CV syllables under a length-based analysis. Since this argument, too, has already been dealt with, it is also excluded from further discussion.

Van Oostendorp’s third argument against using length as a distinctive feature is interesting: ‘there are more A-vowels than B-vowels’ (van Oostendorp 2000:38), where A-vowels are tense/long vowels and B-vowels short/lax. Under length theory, such a situation would be very odd: it would mean that the marked group (the group consisting of fewer members, i.e. the lax vowels) would be allowed to remain fully faithful in phonological implementation, whereas the *un*marked group would be systematically *altered* (i.c. laxed) in the phonological derivation. From a markedness perspective, this would be a completely crossed situation. Let us look at two vowel diagrams of Dutch to see whether they corroborate the problem raised by van Oostendorp:

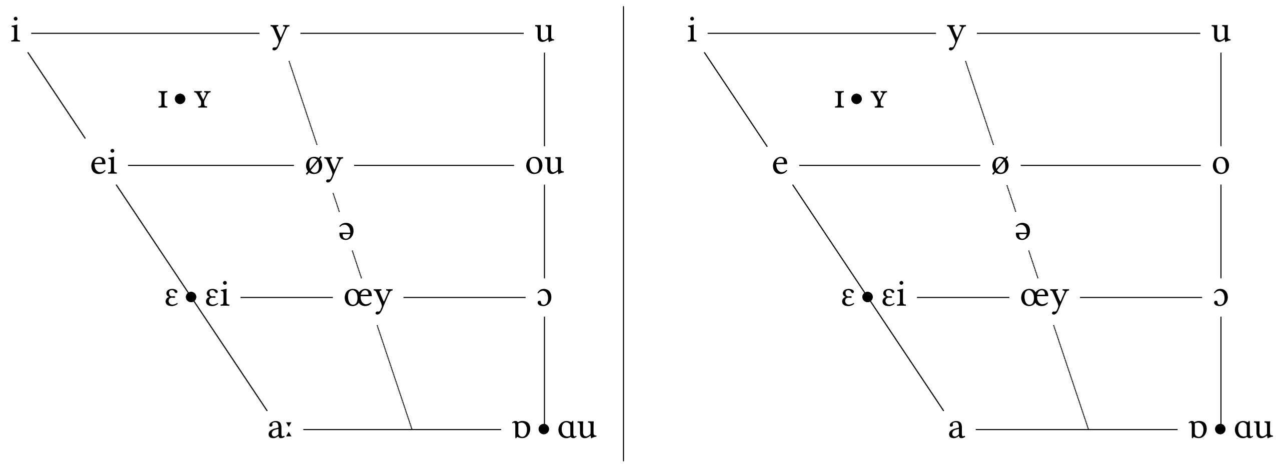


Figure 5: Surface-level diagram of the Dutch vowel space (left) and underlying-level vowel diagram based on tenseness theory (right).

Under tenseness theory (right diagram), van Oostendorp's argument is completely correct: there are seven tense vowels (/i,y,u,e,ø,o,a/) and only six lax vowels (/ɪ,ʏ,ɔ,ɛ,ə,ɒ/). (The diphthongs are excluded from either count because these are a completely separate class, both per tenseness theory and per (25).) But a length-based theory, which would operate at the surface level (left diagram), would not see matters in the same way. Looking purely at the phonetic data, a length-based theory would identify four long vowels (putting the lax diphthongs aside in the interest of a fair comparison) — [ei,øy,ou,aː] versus a total of nine short vowels — [i,y,u,ɪ,ʏ,ɔ,ɛ,ə,ɒ].

What happened here — how can two theories differ on something as basic as counts? The answer is in the high vowels, which are tense yet short. A length-based theory straightforwardly groups these vowels with the lax vowels; in fact, a particularly bold version of length theory might even claim that these vowels actually *are* lax underlyingly, but that this feature is filtered out by van Oostendorp's previously-mentioned '*[high,lax]' constraint. While it is not specifically my intention to argue for this option, it should be clear that van Oostendorp's third argument against length is, in a way, self-defeating, in that it is only a problem when looking at length-based theory from a strictly tenseness-based point of view.

A fourth argument by van Oostendorp (2000) against using length as a phonological feature, and therefore, by the aforementioned mutual entailment of the two theories, an argument in favor of analyzing the tense long vowels as underlyingly short, is that there are morpheme structure constraints that distinguish between tense and lax vowels. The example raised by van Oostendorp is a productive constraint in Dutch barring tautomorphemic [ji] sequences, which is an obvious OCP effect. Van Oostendorp's point with this example is that, though [ji] sequences are banned, [jɪ] sequences are not. Similarly, [wʏ] (*sic*) is also a licit segment sequence, whereas [wy] would not be, from which van Oostendorp concludes that the feature [±tense] must play a crucial role in the phonology of Dutch, since, he apparently argues, it is this feature that should distinguish [i] from [ɪ]. But note that van Oostendorp makes a crucial error in linking these constraints to tenseness theory. As explained in Booij (1995), [ɪ] is not the lax counterpart of [i], but rather of [eː] (which is not phonologically diphthongal in Booij's view). Similarly, [ʏ] is not the lax version of [y], but rather of [øː], again per Booij (1995). In fact, exactly these observations happen to be a crucial tenet of van Oostendorp's (2000) view on the Dutch vowel system! But this crucial oversight in the present argument means that a constraint of the type in (27) need not refer to specifically the tense/lax distinction at all (cf. (27) itself), which means that this argument, too, does not hold.

(27)
$$*\begin{bmatrix}\text{-cons}\\ \text{+approx}\\ \text{-syll}\\ \textsc{dors}\\ \text{+high}\\ \alpha\text{round}\end{bmatrix}\begin{bmatrix}\text{-cons}\\ \text{+approx}\\ \text{+syll}\\ \textsc{dors}\\ \text{+high}\\ \alpha\text{round}\\ \text{-back}\end{bmatrix}\ (\text{i.e. } *\begin{pmatrix}\text{ʋ}\\ \text{j}\end{pmatrix}+\begin{pmatrix}\text{u}\\ \text{i}\end{pmatrix})$$

Van Oostendorp's fifth argument for using tenseness as a phonological feature is that Dutch secret languages (i.c. Goat Latin), and hence Dutch phonology in general, treat long vowels as single segments. That is, a Goat-Latinized (28) would be realized as (29), never as (30):

(28) [tʋei]
⟨twee⟩
'two'

(29) [tʋei.bə.ʋei]

(30) [tʋe.bə.ʋe.i.bə.ʋi]

Observing that the long vowel is never broken up into two segments, from a tenseness point of view this might look like a pretty decent argument in favor of an analysis of long vowels as underlyingly short. However, there are three problems with this position. The first is, as also acknowledged by van Oostendorp, that diphthongs are also treated as single segments by this secret language. That is, a word like (31) would also be realized as (32), and not as (33):

(31) [tɛit]
⟨tijd⟩
'time'

(32) [tɛi.bə.ʋɛit]

(33) [tɛ.bə.ʋɛ.i.bə.ʋit]

This alone makes the argument moot for tenseness-vs.-length purposes: under — surface-true — length theory, all long vowels are analyzed as diphthongs (barring [a:]), and since tenseness theory can't explain the apparent coherence of the diphthongs anyway, it does not make the crucial contribution here that van Oostendorp would hope it to. This brings us to the second problem with the present argument, which is that it actually doesn't have any bearing whatsoever on the present issue. That is, while it does give us an answer to the segment-sequence problem (the answer being that long vowels appear to be segments rather than sequences, but see the next sentence), this does not actually help us in any way decide whether long vowels should be underlyingly short and [+tense], or whether they should be interpreted surface-truly. And the position signalled by this argument on the segment-sequence problem may, in truth, not be so straightforward either — as illustrated in the derivation in table 3, while diphthongs (be they lax or tense) look to be single segments at the lexical level, they are probably 'unfolded' into sequences of individual phones at the postlexical level. A third problem is that, even if van Oostendorp's argument *were* without problems, it would still only reaffirm the inviolability of Syllable Integrity (Kager 1999), which I argue plays the crucial role here — it is actually unwarranted, then, to conclude anything on the tenseness-length debate on the basis of these data, because a completely different type of explanation lends itself in the form of Syllable Integrity. In sum, van Oostendorp's present argument against length does not appear to hold.

Van Oostendorp's sixth and final argument for the phonological reality of [±tense], and hence for the classic view that the long vowels are underlyingly short, is that there are dialects that have a real length contrast. While at the first glance completely irrelevant to the description of (Standard!) Dutch, van Oostendorp crucially derives his argument here from the behavior of the high vowels in these dialects. Just like in Standard Dutch, these dialects, *even those that have a full length contrast*, have short but tense high vowels. Since in these varieties length is phonemic even within the sets of tense and lax vowels, any analysis of those varieties' sound systems will have to include [±tense] as a phonological feature — [±long] already caters to a different phonemic contrast in those varieties. And, van Oostendorp extends this reasoning, if we have to make special arrangements for the ever-short high tense

input	/pɑul/	/døyr/
L-VELARIZATION	pɒːɫ	*n.a.*
MONOPHTHONGIZATION	pɑːɫ	døːr
VOWEL CENTRALIZATION	*n.a.*	døər
output	[pɑːɫ]	[døər]

Table 3: 'Unfolding' of diphthongs after the lexical-postlexical barrier (dashed line). While MONOPHTHONGIZATION operates on diphthongs as single segments (changing [+diphthong] into [-diphthong] in the appropriate context), VOWEL CENTRALIZATION is a much more general, postlexical, rule. This rule is clumsy to formulate in autosegmental phonology, but for illustrative purposes, the following (also somewhat awkward) transformational rule describes the process well:

$$\begin{matrix} V & (V) & r & C_0 & (\sigma) &]_F \\ 1 & 2 & 3 & 4 & 5 & 6 \end{matrix} \Rightarrow 1\ \text{ə}\ 3\ 4\ 5\ 6$$

The key point is that, by design, *1* and *2* (which refer to the first and second V's of which, in our case, a diphthong is composed) visibly refer to different segmental slots. Clearly, for the rule to work correctly, diphthongs must be considered as sequences of two vowel segments – if they were single segments, we would end up with an impossible representation containing a floating mora that is not actually implemented (schwa being considered weightless, Kager 1989). Conveniently and uncoincidentally, I believe, MONOPHTHONGIZATION is a lexical rule (as evidenced by the fact that native speakers can hear the process apply, and, if one does not wish to follow my presumption that [l] must evidently be [-approx], the fact that it has an exception, viz. that heterosyllabic [l] does not trigger the process but both tautosyllabic [ɫ] and other heterosyllabic approximants do), whereas VOWEL CENTRALIZATION is a post-lexical rule (as evidenced by its non-structure-preservingness); I therefore hypothesize the 'unfolding' of single diphthong segments into phone sequences to be the consequence of crossing the lexical-postlexical barrier.

vowels in those varieties anyway, why not carry this analysis over to that of Standard Dutch as well? Note that this is not a true argument in favor of any of the two (tenseness-based or length-based) theories, but rather a note that the odd behavior of the high vowels need not be an insurmountable problem in a tenseness-based theory. But the problem is no less absent in a length-based theory; such a theory could easily analyze the high vowels as being underlyingly short, but blocking them from being assigned laxness by van Oostendorp's own constraint *[high,lax].

The objections I have raised so far against using the feature [±tense] have mostly been theoretical in nature. In the following subsection, I will detail the analysis of Dutch metrical stress as it would be performed under tenseness theory, from which I will gather yet another argument that using [±tense] to solve the Dutch quantity-sensitivity conundrum is not the optimal solution.

2.3. Why stress-to-weight cannot aid tenseness theory

Having discussed all of van Oostendorp's (2000) arguments for using [±tense] as the dominant phonological feature in the tenseness-length debate, and hence having argued against its mutual corollary that the long vowels need to be analyzed as underlyingly short in order to resolve the Dutch quantity-sensitivity conundrum, a fairly big blow has been dealt to tenseness-based theories of Dutch stress. The arguments raised would, however, carry that much more weight if there could also be shown to be a practical component speaking against a tenseness-based analysis, besides the mostly theoretical objections from the preceding subsection. This is what this subsection means to offer.

Recall that tenseness theory relies on the application of an external process, i.c. the Stress-to-Weight Principle (henceforth 'stress-to-weight' or 'SWP'), in order to endow tense vowels with their proper lengths. This section aims to take a closer look at how exactly this process would operate — under tenseness theory. Tableau 1 shows how the derivation of a word like (24) /mo.na.ko/, the key word type that is relevant here. It is crucial to note that, under a tenseness-based analysis, the intended winner ought to be [mo.(náː.ko)].

/mo.na.ko/	SWP	FtBin(μ)	Parse(σ)
mo.(ná.ko)	∗!		∗
☞ (mòː).(nàː).(kóː)			
☹ mo.(náː.ko)		∗!	∗

Tableau 1: A *principled* parallel OT solution to derive stress-to-weight is not possible.

Unfortunately, it appears from tableau 1 that there is a problem when we try to implement Dutch stress-to-weight using only the three constraints that are strictly relevant to it — FtBin(μ), Parse(σ), and SWP, in that tableau 1 turns out to incorrectly favor *[(mò:).(nà:).(kó:)] as opposed to intended [mo.(ná:.ko)]. We can attempt to tackle the problematic form *[(mò:).(nà:).(kó:)] in various ways, all of which turn out to have a flaw:

- attempt to re-rank any of the three constraints SWP, FtBin(μ), Parse(σ): this will obviously not work, since *[(mò:).na.(kó:)] has *zero* violations and therefore harmonically binds intended [mo.(ná:.ko)] in any case;
- add high-ranked *Clash: this would correctly filter out *[(mò:).(nà:).(kó:)], but would replace it by *[(mò:).na.(kó:)] as opposed to intended [mo.(ná:.ko)];
- add high-ranked *Clash plus NonFinality: this would favor a candidate [mo.(ná:).ko], which is phonetically identical to intended [mo.(ná:.ko)]; it is structurally quite different, however, and we will see below that a simpler alternative exists;
- replace FtBin(μ) by a general FtBin constraint, e.g. FtBin(σ/μ): this is not restrictive enough. This solution opens up the seemingly undesirable possibility of also having non-SWP-caused trimoraic feet, e.g. *[ɒn.(dɛ́i.vi)] as opposed to [ɒn.(dɛ́i).vi]. This may become a visible problem in longer words where more than one monomoraic syllable precedes an underlying diphthong;
- rank FtBin(σ) ≫ Parse(σ) ≫ SWP ≫ FtBin(μ): this suffers from the same problem as the previous solution.

They key point to note is that none of the above solutions appear to truly get at the core of the issue, which is that the constraint FtBin(μ) — 'feet should be exactly bimoraic' — is not *surface-true*. That is, while Dutch feet must *in principle* be generated on the basis of exactly two moras, what really happens is that stress-to-weight applies only *after* such feet have been established. This means that FtBin(μ) is a generalization that only holds at the *intermediate* level, but not at the surface level in those cases where SWP had caused a lengthening operation to be applied. Thus, stress-to-weight introduces a principled case of opacity, which parallel OT has notorious difficulty dealing with (Kager 1999).

A principally similar problem is discussed by Jacobs (2008), who employs OT with Candidate Chains (McCarthy 2007) to solve his situation with Latin syncope, which, too, is sabotaged by an overbearing FtBin(μ) constraint. The core problem in Jacobs (2008) is that standard parallel OT fails to predict syncope of the type *sōlĭ́cŭ⟨lŭm⟩* > *sōlĭ́⟨clŭm⟩*, predicting an incorrect stress shift *(sṓlĭ)cŭ⟨lŭm⟩ rather than actual sō(lĭ́)⟨clŭm⟩. The initial solution by Jacobs (2008) to the conundrum is to employ Comparative Markedness to work around the issue. Unfortunately, we cannot do the same: Comparative Markedness makes it possible to distinguish the *underlying* and the surface form, but since there are no feet present in the underlying representation, we seem to require a distinction between an *intermediary form* and the surface form, which is not possible in Comparative Markedness. Jacobs (2008), however, ultimately concludes that Comparative Markedness is not suited for his problem with opaque Latin syncope either, because it generates new incorrect predictions in the non-opaque cases of syncope. For this reason, Jacobs (2008) ultimately switches from standard parallel OT to a serial version, which correctly solves his problem. We will now do the same by switching from parallel OT to Harmonic Serialism (McCarthy 2010), where the serial element provided by Harmonic Serialism's need for continuous stepwise harmonic improvement makes it possible for arrive at intended [mo.(ná:.ko)], as shown below:

1. /mo.na.ko/	SWP	FtBin(μ)	Parse(σ)
mo.na.(kò)	∗	∗!	∗∗
☞ mo.(nà.ko)	∗		∗
2. mo.(nà.ko)	**SWP**	**FtBin(μ)**	**Parse(σ)**
mo.(nà.ko)	∗!		∗
(mò).(nà.ko)	∗!∗	∗	
☞ mo.(nà:.ko)		∗	∗

Tableau 2: Stepwise harmonic improvement eliminates the incorrect winner from tableau 1. Note that the application of the End Rule is omitted for simplicity.

The analysis that would be desired by proponents of stress-to-weight (and thus of tenseness theory) is shown in tableau 2. This works as follows. In the first parse, the first candidate attempts to construct a single-mora foot first in order to obey FtBin(μ) later, after SWP would have made this foot bimoraic. Unfortunately, this is a temporary violation of both SWP and FtBin(μ), and this is less harmonically improving than the competing candidate, which starts out with a correctly bimoraic foot. Thus, because it tries to do too much in a single step, the candidate that would ultimately become [(mò:).(nà:).(kó:)] loses because it is not optimally harmonically improving. Note, importantly, that no candidate [mo.na.(ó:)] has been generated, since this would violate Harmonic Serialism's principle of only making a single change per step; this means that the first-step winner can only be [mo.(nà.ko)]. This candidate then graduates on to the second step, where it is decided that output candidate [mo.(ná:.ko)] will ultimately be more optimal than output candidate [mo.(ná.ko)], which is the desired result.

It thus turns out that stress-to-weight in itself is not a problem; we have now seen that an analysis based on stress-to-weight seems perfectly feasible, given the correct framework is used (Harmonic Serialism, rather than standard parallel OT). The real problem for stress-to-weight in the context of tenseness theory, however, turns out to not be situated within the metrical domain, but rather within the segmental phonology. This second major issue with stress-to-weight in the phonology of Dutch is what we will turn to next.

2.4. Stress-to-weight and diphthongs

As shown in section 1.5, the tense mid vowels are normally realized as diphthongs, but become monophthongs when followed by an approximant within the same foot, just like the lax diphthongs. For at least the lax diphthongs, this is easily represented; as already seen in section 1.4, a rule such as the following could work for them:

F

(34) [+diphthong] → [-diphthong] / _ [+approx]

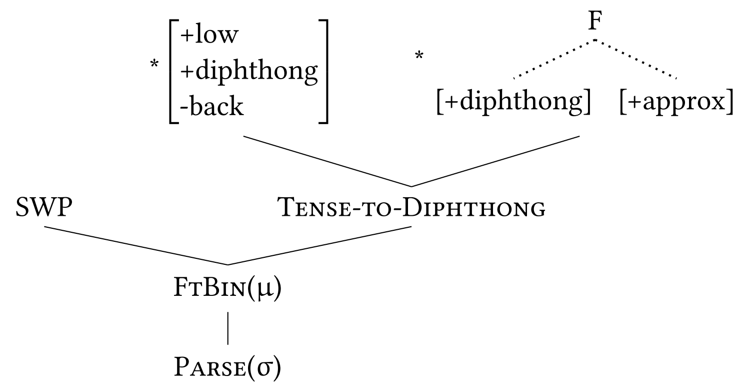
The tense mid vowels have the exact same allophone distribution as the lax diphthongs, and hence need to be subject to the same rule. This means that they need to be analyzed as being underlyingly diphthongal: attempting to analyze the tense mid vowels as underlyingly monophthongal runs into the conspiracy problem, since this would require for diphthongs to monophthongize in the environment specified in (34) and, additionally, for monophthongs to diphthongize in *the exact inverse context* of (34), the latter of which can furthermore not be described as a natural class, in addition to the fact that this rule duplication would amount to generating a phonological conspiracy (cf. Kisseberth 1970).

The obvious remedy to this problem would be to assume that stress-to-weight does not just want stressed syllables to be heavy, but also wants them to be diphthongs. Or rather, as per van Oostendorp (2000), it would want stressed syllables to be *closed*, whereby the head of a diphthong is considered to be a closing segment too — this saves the lax vowels from unjust diphthongization under stress. The problem with this stopgap measure is that these diphthongs can also appear as monophthongs, viz. in (34)'s application context. If we redefine stress-to-weight to require diphthongs, then by that same definition, a monophthongized long vowel would be in violation of stress-to-weight. And if it is in violation of stress-to-weight anyway, then it has no further reason to be long at all: this would just be an unnecessary violation of Dep(μ), since the tense vowels are analyzed as underlyingly short in a stress-to-weight-based analysis founded on tenseness theory.

Thus, a modification of stress-to-weight into 'stress-to-diphthong', given the above, is not tenable. A further possibility could be to invent a specific constraint 'Tense-to-Diphthong', to work in tandem with stress-to-weight. This partially sidesteps the problem, in that it restores stress-to-weight to its original function of only rejecting monomoraic stressed syllables (and hence accepting either diphthongs or long monophthongs), but this 'Tense-to-Diphthong' constraint itself would still be violated by a monophthong. An even-higher-ranked constraint '*[+diphthong],[+approx] within the same foot' would resolve that situation, but this solution has another problem still, namely that it would not be able to predict why /a/ always remains monophthongal, rather than diphthongizing to *[ai]. This could be remedied by yet another constraint, such as '$*\begin{bmatrix}\text{+low}\\ \text{+diphthong}\end{bmatrix}$' (which looks reasonable from a phonotactic point of view, since, one could presume, the distance to be traveled by such a gesture would be too great to complete in too little time, Dutch diphthongs always being fully upgliding), but such a constraint would wrongfully exclude the diphthong /ɑu/, whose existance furthermore invalidates a phonotactics-based justification of such a constraint and would hence render a subsequent improvement '$*\begin{bmatrix}\text{+low}\\ \text{+diphthong}\\ \text{-back}\end{bmatrix}$' wholly arbitrary. The latter is a major problem specifically within OT, as in OT it is assumed that all constraints are universal and that languages only differ on the *ranking* of these constraints.

Suppose for a moment that we were to go down the road laid out in the previous paragraph. That is, we take the presently-accepted tenseness-/stress-to-weight-based approach to the metrical phonology of Dutch (e.g. the analysis by Gussenhoven 2009), and we update it with the segmental facts established in section 1 by postulating the above-mentioned constraint Tense-to-Diphthong and its corollaries mentioned in the previous paragraph. The resulting constraint topology would be the following:

(35)



Note that under this analysis, SWP actually does very little; its effects are effectively superseded by Tense-to-Diphthong, a constraint which is required independently of SWP for two reasons: first of all, we require stressed syllables to become diphthongs, an issue which SWP can only partially help us with, in that it can give us the second mora but not the upgliding gesture to go along with it; second, the same diphthongization must also take place for *unstressed* syllables, where SWP is utterly powerless to help to begin with. Furthermore, in order to work around the conspiracy problem caused by assuming underlyingly monophthongal forms for the tense mid vowels, we have had to assume some very specific constraints and combinations thereof. From an OT point of view, such specificity is problematic, since all constraints ought to be universal in nature; this means that general constraints are to be preferred at all times over specific 'stop-gap' constraints, which we required here. Neither of these two problems is truly fatal, but all taken together it is clear that an adjustment is needed.

2.5. Short tense vowels

What we would ideally like to do is to replace Tense-to-Diphthong and $*\begin{bmatrix}\text{+low}\\ \text{+diphthong}\end{bmatrix}$ with something just a little less ad-hoc. Intuitively, the generalizations that these constraints express should be directly reflected in the underlying forms, rather than being derived through mystique and specialized constraints. We will see in this section that what looks at a first glance to be a reduction process in the synchronic phonology of Dutch will actually turn out to provide us with the key argument that we need to make this happen.

Observe first that, in words such as (23) [a.(ɣέn).da], a tense [a] occurs that is not long, but short. According to Heemskerk & Zonneveld (2000), this is because tense vowels tend to be reduced when in unstressed position. We could formulate this process by means of a phonological constraint such as (36):

(36) Reduce(w): *reduce weak syllables (by clipping a mora).*

This constraint seems remarkably familiar: it essentially duplicates the functionality served by SWP, but from the opposite angle. This constraint makes one further prediction, however, viz. the (introspectively correct) prediction that tense diphthongs in unstressed position should be *compressed*. The process would be as follows: when Reduce(w) encounters a word such as (24) [mou.(náː.kou)], it delinks the two (unstressed) diphthongs' second moras from their syllable nodes. The second component of the diphthongs can then simply be reattached by Stray Adjunction, salvaging the segmental material that would have been lost by the mora's delinking:

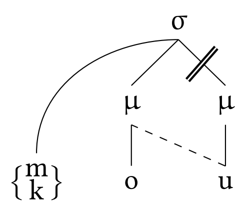


Figure 6: Mora clipping of the (unstressed) first/last syllable of /mou.naː.kou/ results in a compressed diphthong [o͜u] (due to stray adjunction of the segment attached to the delinked mora).

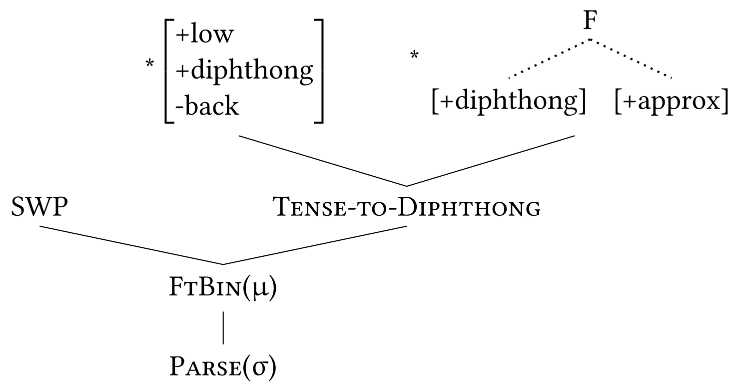
Note that this may in fact be the reason why phonologists have been so reluctant to abandon tenseness theory and admit that the tense mid vowels are diphthongs: at the surface level, a compressed diphthong [o͜u] is almost indistinguishable from a regular short [o] (note that both are monomoraic!), especially given the fact that it has long been known that this [o] can be diphthongized phonetically. Furthermore, this incorrect but convenient assumption that [o] derives from an underlying monophthong also tunes in naturally with the tenseness-based account of Dutch word stress, as most clearly articulated by Gussenhoven (2009). And lastly, a phonologist adhering to the tenseness-based view can easily analyze the diphthongization of stressed [ou] as being a phonetic by-effect due to additional emphasis licensed by stress-to-weight, a view which is further strengthened when the phonologist fails to recognize [o͜u] as a compressed diphthong, rather than as a short monophthong.

However, the analysis offered above is not satisfactory, in that it results in an approach to vowel quantity from two fronts: SWP to lengthen when stressed, and Reduce(w) to shorten when unstressed. At this point, an obvious resolution to the problems we ended up with in section 2.4 becomes clear. Recall that, segmentally, it is unavoidable that the tense mid vowels must be diphthongs (section 1), so we will let them be so. The prosodically-conditioned effect that is embodied by Reduce(w), however, appears to be nothing more than a cumbersome formulation of what could be elegantly stated to be SWP. Now, the key insight that these two facts taken together can provide us with is that we should then consider an underlying representation like the following for the tense mid vowels:

(37)
$$\begin{array}{c}\mu\\ |\\ \underset{\smile}{\text{ei}}\end{array}$$

In this case, we are drawing a very clear line between the contradictory segmental and prosodic phonologies. When it comes to metrical stress, the prosodic phonology will lead, permitting an analysis of Dutch that is very much like the original stress-to-weight-based analysis offered in section 2.3, repeated below as (38):

(38)



However, and this is the crucial part, the extremely arbitrary constraint $*\begin{bmatrix}\text{+low}\\ \text{+diphthong}\\ \text{-back}\end{bmatrix}$ and the also odd (as it would make the key element of the analysis — i.e. SWP — partially redundant) constraint Tense-to-Diphthong will be replaced by (faithfulness constraints referring to) the underlying form. This crucial simplyfing move is only possible if we allow for underlying representations like (37). Then SWP — rightfully so — will govern all aspects of vowel quantity in Dutch, regulating the length of all tense vowels by adjoining a second mora to the vowel (which will either be a monomoraic tense diphthong or short tense /a/) when it is stressed, resulting in a genuinely proper diphthong (or unexciting [a:]), or a compressed diphthong (or short tense [a]) otherwise.

With this new take on the facts, all constraints that we need are captured by the following topology (note that only the minimum constraints necessary for the argument are shown — of course we will also need, e.g., Dep(μ) at a low-ranked position):

(39) SWP
|
FtBin(μ)
|
Parse(σ)

This can be applied to our three example words (22–24):

1. /ɒn.dɛi.vi/	SWP	FtBin(μ)	Parse(σ)
ɒn.(dɛ́i.vi)		∗!	∗
☞ ɒn.(dɛ́i).vi			∗∗

Tableau 3: Given our assumptions and framework, nothing remarkable needs to be said about deriving [ɒn.dɛ́i.vi], save for the remark that [ɒn] is not footed due to clash avoidance (*clash not pictured in the present tableau).

1. /a.ɣɛn.da/	SWP	FtBin(μ)	Parse(σ)
a.ɣɛn.(dá)	∗!	∗	∗∗
☞ a.(ɣɛ́n).da			∗∗

Tableau 4: Thanks to stress-to-weight, there is no need to reduce [a] via Reduce(w), as the vowel is monomoraic by default, as all tense vowels are.

1. /mo͜u.na.ko͜u/	SWP	FtBin(μ)	Parse(σ)
mo͜u.na.(kó͜u)	∗	∗!	∗∗
☞ mo͜u.(ná.ko͜u)	∗		∗
2. mo͜u.(ńa.ko͜u)	SWP	FtBin(μ)	Parse(σ)
mo͜u.(ná.ko͜u)	∗!		∗
☞ mo͜u.(náː.kou)		∗	∗

Tableau 5: Similarly to tableau 4, there is no need to explicitly compress the $[\left\{\begin{smallmatrix}\text{m}\\ \text{k}\end{smallmatrix}\right\}$o͜u$]$ syllables; they can simply remain monomoraic as they were underlyingly.

Not only does the above analysis work out, it is also vastly simpler than the analysis offered in section 2.4: the two bizarre and arbitrary constraints Tense-to-Diphthong and $*\begin{bmatrix}\text{+low}\\ \text{+diphthong}\\ \text{-back}\end{bmatrix}$ have been replaced by sensible and motivated references to the underlying form. An interesting feature of the above analysis to note is that it presumes that *both* tenseness and length play a role at the underlying level. This is, in fact, the crucial necessity for the present analysis: if we want segmental diphthongization of tense vowels (which entails length or bimoraicity) to be contradictable by prosodic monomoraicity for only tense diphthongs, both tenseness and length need to be specified underlyingly, crucially contradictory so. This, I submit, is the key strength of the presently-presented analysis: it resolves the contradiction between the segmental phonology (discussed in section 1) and the prosodic phonology (the subject of section 2) not by picking sides between the two, but rather by simply making the phonological contradiction explicit, thereby arriving at a synthesis that can explain all the facts without contradicting itself as a theory or ignoring half of these facts (cf. the standard tenseness-based theory discussed in section 2, which had to blatantly ignore the diphthongization of the tense mid vowels).

2.6. Conclusion

Given the above, it would appear that the Dutch phonological system is the true embodiment of sound change in progress. On the one hand, the unified segmental behavior of the tense mid vowels and the lax diphthongs suggests that these vowels are all diphthongs. On the other hand, the distinct prosodic behaviors of the tense mid vowels and the lax diphthongs suggests that these two sets of vowels are clearly distinct, tense vowels being metrically short. While the classic analysis of using underlying short monophthongs for the tense vowels fails in being unable to deliver the correct segmental allophone patterns (section 2), we have seen that an analysis that acknowledges these changes in segmental quality must also acknowledge the metrical differences between the (new) tense diphthongs vs. the age-old lax diphthongs. What we can learn from these facts is that the sound change that is the diphthongization of the Dutch tense mid vowels is progressing through the sound system in a truly stepwise fashion: while the segmental phonology has wholly succumbed to the change, the prosodic phonology apparently still has some catching up to do.

3. Conclusion

This paper was a more or less successful attempt to formalize the synchronic phonology of Dutch, given what we know about it. Our point of departure (section 1) was the segmental phonology, where it was observed that the tense mid vowels were not only underlyingly diphthongal (as evidenced by their allophone patterns, which could only be formalized if the diphthongal realization was taken as the underlying form), but that they also formed a natural segment class with the lax diphthongs. We then discovered in section 2 that an analysis on the sole basis of the feature [±tense] failed to succeed, confirming that the underlying diphthongal forms for the tense mid vowels were a true theoretical necessity in order to be able to account for the patterns in the segmental phonology. Underlying bimoraicity for tense vowels, however, turned out to be highly problematic for the currently-accepted analysis of the stress system of Dutch. Fortunately, we concluded section 2 with a coherent analysis of these stubbornly contradictory facts after all, by recognizing the (segmental) changes that have occurred in present-day Dutch, but at the same time acknowledging that these are not yet complete (viz. have not yet penetrated the metrical phonology).

For the prosodic part, an extra cautionary tale needs to be told, since although the system as we formulated it is elegant, we must remain open to another possibility: that the system as such does not actually exist. It is possible that the reason why the prosodic phonology seems so stubbornly conservative is that it simply *does not exist anymore*, and that any stress patterns we phonologists find are nothing more than accidental historical contingencies, rather than synchronic rules. This very conclusion is independently reached by van Oostendorp (2012), on the basis of a much larger sample of the stress phonology of Dutch. Fortunately, this is not necessarily the case, and may even be necessarily not the case: even if the stress system of (the tense mid vowels of) Dutch might be becoming mostly lexical in the long run, this still does not excuse us from having to describe it as well as we can, because *native speakers still have intuitions about it*, and hence apparently still have (at least some) rules. In fact, extremely recent evidence by Voeten & van Oostendorp (submitted) on an extremely-large-scale study (1,774 participants $\times$ 307 words; 76,782 cells filled) testing exclusively non-sense words (which by definition cannot tap into any lexically stored stress patterns) found that the stress system of Dutch actually matches up extremely well with the literature that has attempted to describe it, discrediting van Oostendorp's (2012) claim that Dutch stress is so complex and arbitrary nowadays that it must be wholly lexical. To top this up, the problematic apparent metrical lightness of tense vowels was in fact one of the most robust findings reported by Voeten & van Oostendorp (submitted), meaning that if *anything* is a robust pattern in the stress phonology of Dutch, it must be this disputed (cf. section 2.2) one. Thus, there still is such a thing as 'the stress *system* of Dutch', and I dare say it probably closely mirrors the analysis presented in section 2.5.

In closing, I return to Hyman's (1976) model of sound change, which proceeded in terms of phonetic variation, phonologization, phonemicization (with concomitant rule inversion), and loss. Given what we have seen in the preceding, it is clear that the diphthongization of the tense mid vowels has reached the ‘loss’ stage segmentally (cf. section 1, where we saw that the old feature [±tense] had been wholly replaced by the novel feature [±diphthong]), but only phonologized as far as the prosody of Dutch is concerned (as the vowels in question are metrically still composed of a single mora, rather than the two moras that one would expect a diphthong to have). Thus, the next step in the sound change is obvious: at some point, the tense mid vowels will be reanalyzed as diphthongs at the prosodic level as well, meaning that they will become underlyingly bimoraic. This will cause an abrupt shift in the phonology of Dutch as a whole: when this happens, /a:/ will be the only survivor of the original, tenseness-based, system. What happens then I leave to future work — though only because we do not have the data yet. One thing is certain though: Dutch is in the middle of a vowel shift, and exiting times are ahead.

References

Aitchison, J. (2001). *Language change: progress or decay?*. Cambridge: Cambridge University Press.

Berns, J. & Jacobs, H.M.G.M. (2012). A first glance at the role of length in production and perception of diphthongs before Dutch coda *l*. *Linguistics in the Netherlands* 2012, pp. 15–26.

Blancquaert, E. (1969). *Praktische uitspraakleer van de Nederlandse taal*. Antwerpen: De Sikkel.

Booij, E.E. (1995). *The Phonology of Dutch*. Oxford: Oxford University Press.

Botma, B., Sebregts, K., & Smakman, D. (2012). The phonetics and phonology of Dutch mid vowels before /l/. *Laboratory Phonology* 3-2, pp. 273–297.

Fischer, O.C.M., Koopman, W.F., van Kemenade, A., & van der Wurff, W. (2000). The syntax of Early English. Cambridge Syntax Guides. Cambridge: Cambridge University Press.

Goossens, J., Taeldeman, J., & Verleyen, G. (2000). Fonologische Atlas van de Nederlandse Dialecten. Deel III: de Westgermaanse lange vocalen en diftongen. Gent: Koninklijke Academie voor Nederlandse Taal- en Letterkunde.

Gussenhoven, C. (1993). The Dutch Foot and the Chanted Call. *Journal of Linguistics*, pp. 37–63.

Gussenhoven, C. (1999). *Handbook of the International Phonetic Association: A Guide to the Use of the International Phonetic Alphabet: Dutch*. Retrieved September 19, 2012, from `http://ia600500.us.archiv` e.org/3/items/rosettaproject_nld_phon-3/rosettaproject_nld_phon-3.pdf.

Gussenhoven, C. (2009). Vowel duration, syllable quantity, and stress in Dutch. In: Hansson, K. & Inkelas, S. (Eds.). *The Nature of the Word. Essays in Honor of Paul Kiparsky* (pp. 181-–198). Cambridge/London: MIT Press.

van Haeringen, C.B. (1924). Eenheid en nuance in beschaafde-Nederlandse uitspraak. *De Nieuwe Taalgids* 18, p. 65.

van Haeringen, C.B. (1949). Gedistingeerdheid in taal. *De Nieuwe Taalgids* 42, pp. 1–10.

Hamann, S. (2014). Phonological changes. In: Bowern, C. & Evans, B. (Eds.). *The Routledge Handbook of Historical Linguistics.* London: Routledge.

van der Harst, S. (2011). The Vowel Space Paradox: A Sociophonetic Study on Dutch. Utrecht: LOT.

Hayes, B. (1995). *Metrical stress theory: Principles and case studies.* Chicago: University of Chicago Press.

Heemskerk, J. & Zonneveld, W. (2000). *Uitspraakwoordenboek.* Utrecht: Het Spectrum B.V..

van Hout, R.W.N.M., de Schutter, G., de Crom, E., Huinck, W., Kloots, H., & Van de Velde, H. (1999). De uitspraak van het Standaard-Nederlands. Variatie en varianten in Vlaanderen en Nederland. *Artikelen van de derde sociolinguïstische conferentie*, pp. 183–196.

Hyman, L.M. (1976). Phonologization. In: Juilland, A. (Ed.). *Linguistic Studies Offered to Joseph Greenberg* (pp. 32–43). Saratoga: Anima Libri.

Jacobs, H.M.G.M (2008). Sympathy, comparative markedness, OT-CC and Latin syncope. *Probus* 20(2), pp. 235–255.

Kager, R. (1989). *A Metrical Theory of Stress and Destressing in English and Dutch.* Dordrecht: Foris.

Kager, R. (1999). *Optimality Theory.* Cambridge: Cambridge University Press.

Kisseberth, C. (1970). On the functional unity of phonological rules. *Linguistic Inquiry* 1, pp. 291–306.

Kroch, A. (2008). Syntactic change. In: Baltin, M. & Collins, C. (Eds.). *The handbook of contemporary syntactic theory*, pp. 699–729.

Labov, W., Yaeger, M. & Steiner, R. (1972). *A quantitative study of sound change in progress*. Philadelphia: University of Philadelphia.

Labov, W. (1994). *Principles of Linguistics Change. Volume I: Internal Factors*. Oxford/Cambridge: Blackwell.

Lahiri, A. & Koreman, J. (1988). Syllable Weight and Quantity in Dutch. *West Coast Conference on Formal Linguistics* 7, pp. 286–299.

McCarthy, J.J. (2007). *Hidden generalizations: phonological opacity in Optimality Theory*. London: Equinox.

McCarthy, J.J. (2010). An Introduction to Harmonic Serialism. *Language and Linguistics Compass* 4(10), pp. 1001–1018.

Ohala, J.J. (1981). The listener as a source of sound change. In: Masek, C.S., Hendrick, R.A., & Miller, M.F. (Eds.). *Proceedings of the Chicago Linguistics Society 17: Papers from the Parasession on Language and Behaviour* (pp. 178–203).

van Oostendorp, M. (2000). *Phonological Projection. A Theory of Feature Content and Prosodic Structure*. Berlin: Mouton de Gruyter.

van Oostendorp, M. (2012). Quantity and the Three-Syllable Window in Dutch Word Stress. *Language and Linguistics Compass* 6(6), pp. 343–358.

van Reenen, P. & Jongkind, A. (2000). De Vocalisering van de /l/ in het Standaard Nederlands. *Taal en Tongval* 52, pp. 189–199.

Stroop, J. (1998). *Poldernederlands. Waardoor het ABN verdwijnt*. Amsterdam: Bert Bakker.

van der Torre, E.J. (2003). *Dutch Sonorants: The Role of Place of Articulation in Phonotactics*. Utrecht: LOT Publications.

Van de Velde, H. (1996). *Variatie en verandering in het gesproken Standaard-Nederlands*. Nijmegen: Katholieke Universiteit Nijmegen.

Van de Velde, H. & van Hout, R.W.N.M. (2003). Diftongering in het Standaard-Nederlands. *Artikelen van de vierde sociolinguïstische conferentie*, pp. 486–497.

Voeten, C.C. & van Oostendorp, M. (submitted). The stress pattern of Dutch monomorphemes: a pilot empirical study. Manuscript submitted to *Journal of Linguistics*.

Voortman, B. (1994). *Regionale variatie in het taalgebruik van notabelen. Een sociolinguïstisch onderzoek in Middelburg, Roermond en Zutphen.* Amsterdam: IFOTT.

Zwaardemaker, H. & Eijkman, L.P.H. (1924). *Leerboek der Phonetiek. Inzonderheid met betrekking tot het Standaard-Nederlands.* Haarlem: De erven F. Bohn.

Endnotes

[†] The exact conditioning environment of this rule is a bit mysterious. First, note that MONOPHTHONGIZATION must be confined to at least the foot, since a linearly unconfined MONOPHTHONGIZATION would incorrectly neutralize the distinction between [(stroːj͡).(ɔŋ͡.ə)] ‘sprinkling boy’ and [(strou).(jɔŋ͡.ə)] ‘straw boy’ (the high tiebar provisorily indicating ambisyllabicity for the [j] segment). The question is whether the conditioning environment should not be further narrowed to the syllable, rather than the foot. I believe the answer to this question to be negative, since the effect *can* in fact cross syllable boundaries: compare *[ei.ʋə] and $^{\text{OK}}$[eː.ʋə] ‘centuries’. Note that this can also be analyzed as an ambisyllabic situation, i.e. that the [ʋ] segment is actually also a coda consonant for the [eː] syllable, but this seems a dangerous assumption with respect to both the morphology-phonology interface as well as Dutch syllable structure. For this reason, I will assume a foot-based conditioning environment; a further confinement to the syllable might be possible, but is not necessary.

A problematic issue with the above, however, concerns the phoneme /l/: for this phoneme, the effect clearly needs to be confined to the *syllable*, rather than the foot: compare $^{\text{OK}}$[dei.lə] ‘parts’ (N) / ‘to share’ with incorrect *[deː.lə]. It should be noted that this has no bearing on the previous discussion regarding ambisyllabicity, since the morphological structure of this word is either /deil/ ‘part’ (N) + [ə] ‘PL’ or /deil/ ‘share’ (V) + [ə] ‘INF’; this means that the [l] segment should be just as ambisyllabic as the [ʋ] segment in [eː.ʋə], meaning that assuming a syllable-based confinement compounded with ambisyllabicity does not actually help resolve the problematic status of /l/. One possible solution is to assume, controversially, that the /l/ triggering MONOPHTHONGIZATION can only be dark [ɫ] and never clear [l]; in other words: [l] is specified [-approx]. Though controversial, this still seems the cleanest analysis for the problematic status of /l/: it is certainly better than assuming two separate rules, one for all approximants that are not /l/ (which cannot even be formalized as a natural class!) with either a foot-based conditioning environment or a syllable-based conditioning environment allowing ambisyllabicity, plus one more for /l/ only with a conditioning environment of the syllable.

Another alternative could be to have the conditioning environment be the syllable, and have words like *[ei.ʋə] be handled through some sort of OCP effect, if we assume that an open syllable [ei] is — in and of itself — virtually indistinguishible from a putative sequence [ej], and that this latter sequence may not precede [ʋ] because of a clash between the two then-adjacent glides *[jʋ], or *[iʋ] under the assumption that [ei] and [ej] are equivalent with respect to this effect. This would postulate a syllable-crossing effect when the consonant following the diphthong is one of the glides [j,ʋ], and no syllable-crossing when the following consonant is a liquid [l,r] (the inclusion of [r] is unproblematic since [r] can be plausibly argued to be governed by a different rule, viz. VOWEL CENTRALIZATION (Gussenhoven 1993). These assumptions are also capable of generating the correct output forms.

Whichever of these assumptions ultimately turns out to be correct, for purposes of this paper it seems easiest to assume that the conditioning environment for MONOPHTHONGIZATION is the foot: within one and the same foot, MONOPHTHONGIZATION is applicable when the [+diphthong] segment is followed by a [+approx] segment, which is [ɫ,r,ʋ,j] but not [l]. If one so desires, one could substitute the syllable for the foot in the preceding, with different assumptions required on either ambisyllabicity or diphthong composition.

Appendices

On the following final pages follow those graphs and tables that were too large to be included in-situ.

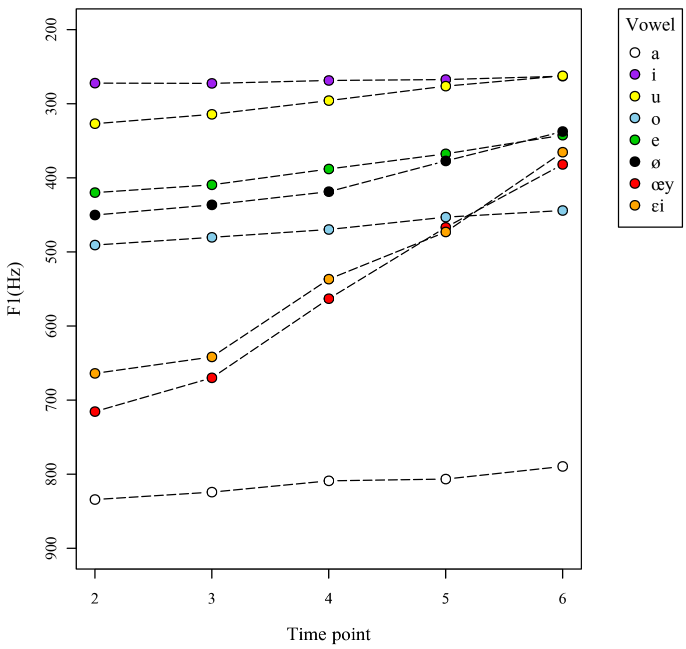


Figure 7: F1 values for C_0__s words. The time points 2 to 6 correspond to the 12,5%-intervals of 25% to 75% realization.

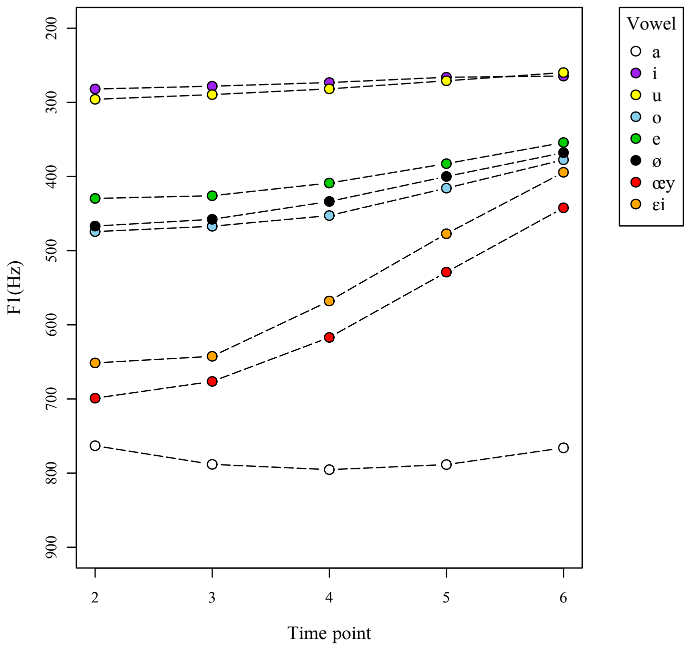


Figure 8: F1 values for C_0__t words. The time points 2 to 6 correspond to the 12,5%-intervals of 25% to 75% realization.

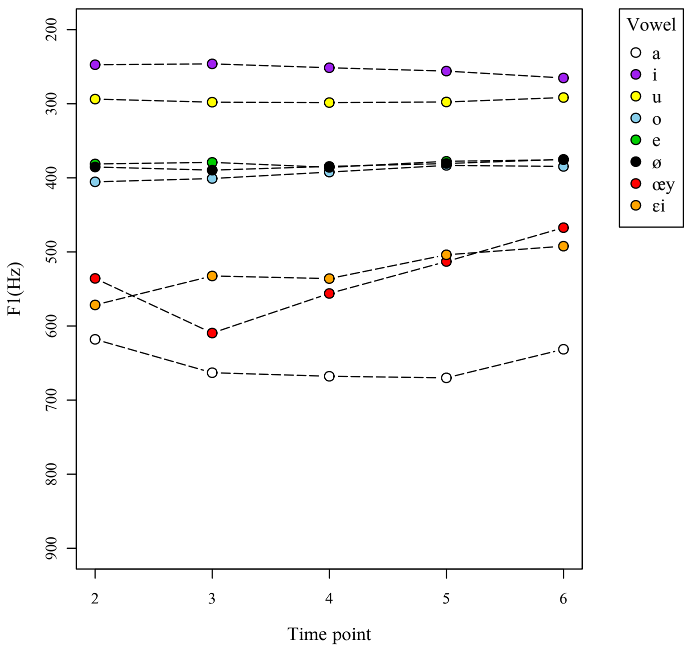


Figure 9: F1 values for C_0__ɫ words. The time points 2 to 6 correspond to the 12,5%-intervals of 25% to 75% realization.

Table 4: Interactions featuring the between-subject factor GENDER.

vowel	TIME × GENDER	CONTEXT × GENDER	TIME ×CONTEXT ×GENDER
(a)	0.015	0.185	0.185
(i)	0.072	0.370	0.227
(u)	0.134	0.040	0.003
(o)	0.001	0.567	0.217
(e)	0.089	0.012	0.230
(ø)	0.963	0.359	0.587
(œy)	0.334	0.029	0.475
(εi)	0.573	0.098	0.000

Table 5: Average F1 values.

vowel	context	time point 12.5%	25%	37.5%	50%	62.5%	75%	87.5%
(a)	s	819.45	834.2	824.21	808.97	806.58	789.52	773.55
	t	718.6	763.05	788.2	795.3	788.5	765.9	714.35
	l	545.16	618	663.04	667.83	669.97	631.37	573.96
(i)	s	268.66	272.18	272.52	268.59	267.37	262.82	255.7
	t	286.75	281.95	278.15	273.2	266.1	264.5	246.15
	l	241.88	247.34	246.2	251.44	255.93	265.23	272.53
(u)	s	318.51	326.93	314.3	295.76	276.24	262.36	238.81
	t	295.7	295.8	289.5	281.75	270.85	259.75	230.15
	l	292.07	293.75	297.9	298.46	297.62	291.62	289.92
(o)	s	493.66	490.73	480.31	469.74	453.04	444.1	439.12
	t	460.15	474.25	467.05	452.6	415.65	377.4	324.15
	l	372.98	405.42	400.93	392.24	383.21	384.63	357.57
(e)	s	408.31	419.94	409.43	388.09	367.6	342.46	314.56
	t	414.15	429.5	425.85	408.75	382.6	354.1	320.05
	l	368.97	381.26	379.12	385.89	377.69	375.56	377.14
(ø)	s	435.32	450.19	436.49	418.68	377.2	337.52	317.26
	t	463	466.8	457.65	433.6	399.9	367.8	328.65
	l	370.46	385.38	389.62	384.61	380.68	375.08	370.48
(œy)	s	753.81	715.52	669.94	563.14	466.87	381.92	333.51
	t	684.35	698.95	676.35	617	528.9	442.15	385.35
	l	593.23	535.75	609.49	556.08	512.97	467.28	448.93
(εi)	s	664.67	663.94	641.74	536.75	473.07	365.42	327.94
	t	609.25	651.35	642.45	567.85	477.1	394.25	343
	l	555.18	571.57	532.46	536.01	503.87	492.24	481.58

Table 6: Average F2 values.

vowel	context	time point						
		12.5%	25%	37.5%	50%	62.5%	75%	87.5%
(a)	s	1505.85	1508.29	1486.52	1470	1470.83	1452.02	1447.65
	t	1502.2	1476.95	1475.45	1480.6	1460.4	1422	1385.1
	1	1559.08	1458.93	1383.22	1346.76	1249.08	1203	1114.1
(i)	s	2301.76	2315.82	2327.45	2333.15	2332.69	2341.93	2334.95
	t	2084.45	2183.5	2256.55	2288.6	2290.85	2267.85	2157.1
	1	2281.44	2313.87	2267.91	2244.75	2147.13	2124.17	1960.64
(u)	s	823.64	808.12	809.4	802.96	837	932.58	1035.1
	t	902.5	856.95	861.1	882.65	916.45	968.15	1021.5
	1	975.26	875.35	815.57	791.21	789.75	809.06	822.33
(o)	s	1019.84	996.94	961.36	944.2	925.74	936.16	1001.05
	t	1033.75	1009.6	969.4	936.35	924.5	921.75	971.25
	1	1192.9	1031.04	934.41	897.71	853.89	817.45	768.65
(e)	s	2031.45	2104.08	2137.25	2212.66	2263.14	2294.13	2282.73
	t	1945.05	2022.45	2070.75	2151	2215.55	2261	2258.05
	1	2108.91	2118.53	2130.79	2104.15	1990.99	1783.9	1568.67
(ø)	s	1634.06	1617.73	1609.47	1596.98	1609.39	1633.9	1704.53
	t	1671.75	1657.55	1645.25	1650.4	1667.2	1701.9	1758.05
	1	1414.65	1439.2	1446.14	1432.27	1340.45	1301.39	1205.65
(œy)	s	1561.29	1540.95	1549.53	1572.16	1586.96	1601.99	1669.5
	t	1498.35	1523.15	1538.5	1553	1560.1	1563.95	1591.25
	1	1492.19	1484.15	1460.09	1499.15	1421.45	1351.37	1290.72
(εi)	s	1828.86	1892.99	1957.05	2020.44	2106.79	2183.07	2196.03
	t	1700.95	1777.2	1841.75	1913.95	2008	2054.3	2089.6
	1	1857.1	1851.72	1868.89	1885.21	1879.07	1842.98	1759.18