Phonetic reductions and linguistic factors

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Abstract

In natural communication it is common for speakers to vary between distinct and reduced pronunciations of words or phonemic strings. This paper highlights the some results from a recent large scale study of the occurence of phonetic reductions in Danish spontaneous speech. In this study phonetic reduction is explored by mapping the abstract phonemic representation in a spontaneous speech corpus with the actual phonetic realization on a phone-by-phone basis. By investigating the occurence of distinct vs. reduced realizations of phonemes, it is demonstrated that the propensity for phonetic reduction is closely related to various levels of linguistic description, e.g. the articulatory traits of the individual phonemes, their phonological context, morphological structure, grammatical function and pragmatic factors.

Keywords: *Phonetic reduction; phonology; morphology; syntax; spontaneous speech.*

1. Introduction

It is a well-known characteristic trait of casual speech that words are sometimes pronounced distinctly, e.g. [ˌfoʊnəˈtɪʃən] *phonetician,* and sometimes more reduced, e.g. [fənˈtɪʃn̩] or various intermediate forms. Lenition and elision of parts of or entire words are often frowned upon by laymen and language purists. From the linguistically naïve point of view phonetic reductions are typically considered a sign of sloppiness, and people are often worried that such carelessness will hurt the language and ultimately our ability to communicate and understand each other. Phonetic reductions also seem to pose problems with regards to speech technology, and linguistic research is sometimes concerned with the intelligibility of reduced forms

(for an overview, see Ernestus and Warner 2011), presupposing that reduced forms must be less intelligible, and perhaps more problematic in various ways, than corresponding full forms. On the other hand, recent research suggests a different view on phonetic reductions, where form variation is seen as connected to linguistic function (e.g. Heegård 2012, 2013).

Rather than viewing phonetic reductions as a problem for speech understanding, this paper suggests that phonetic reductions should be treated as a functional and intregrated part of the speech code. Simply put, a speaker's rapid changes between expanded and reduced pronunciation correlate with his/her communicative goals and are necessary for fluent communication. With this perspective the aim of this paper is to emphasise the role of reductions in grammatical and discourse contexts.

Expanded and reduced forms may co-exist within the same conversation, phrase or even within a single word, where some parts have a distinct pronunciation while other parts are lenited or elided. In spite the prevalence of such reductions (for an overview, see Ernestus & Warner 2011), the phonetic and phonological literature is sparse on descriptions of when to apply or expect a distinct vs. a reduced realization of a given phonemic string. In this paper it is demonstrated that the phonetic behavior, i.e. the variation between more or less expanded and reduced forms, is closely related to various levels of linguistic abstraction. The points presented here are based on a recent PhD dissertation on phonetic reductions in Danish (Schachtenhaufen 2013). The examples given here will therefore be from Danish, but they are used to illustrate points that can be expected in languages in general. It should be noted that investigating phonetic reductions in spontaneous speech is quite complicated since many factors, both linguistic and extra-linguistic, are involved. Due to the format of this paper, it is obvious that many details must be omitted.

2. Method

In order to investigate phonetic reductions the [DanPASS corpus (*Danish Phonetically Annotated Spontaneous Speech*](); Grønnum 2009) was utilized. The corpus consists of monologues and dialogues, where speakers are given different tasks, such as map tasks, descriptive tasks, etc., that must be solved verbally. The corpus is supplied with both phonemic representation

and phonetic transcriptions, as well as with many other levels of annotation, including part-of-speech, various prosodic information etc.

For this investigation, a canonical pronunciation was derived from the phonemic representation by applying general, well-known Danish phoneme-to-allophone rules (Grønnum 2005), e.g. vowel change before or after /r/, lenition of consonants in coda position, etc. Thus, for a word, e.g. *kornmarker* 'corn fields', we have:

Phonemic representation   /ˈkornmarkər/
Canonical pronunciation   /ˈkoɐ̯nmɑːgɐ/[1]
Actual pronunciation   [ˈkoɐ̯nmɑɣɐ][2]

While the phonemic representation and the canonical pronunciation are constant for every instance of the word *kornmarker*, the actual pronunciation may vary between the fully expanded [ˈkoɐ̯nmɑːgɐ] to various reduced forms, [ˈkoɐ̯nmɑːɣɐ ˈkɔnmɑɣɐ ˈxoɐ̯nmɑːɣɐ] etc.

In the next step, a mapping between the segments in the canonical and actual pronunciation was carried out, e.g. in the actual pronunciation [ˈkoɐ̯nmɑɣɐ] where we would expect a [g] from the canonical pronunciation, but the actual pronunciation is [ɣ], thus /g/ → [ɣ]. In so far as the number of segments is the same in both of these representations, this mapping is mostly straightforward. It is somewhat trickier when there are disagreements between the two tiers, e.g. in the case of contraction, as in the phrase:

Transcription   [ˈəxmuðˀʌ]
Canonical form   /nɒːˀ du kʌmˀɐ uðˀ æːˀ/
Orthography   'når du kommer ud af'
Glossing   'when you come out of'
Translation   'when you exit'

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[1] To distinguish between canonical pronunciation and actual transcription, in this paper canonical pronunciations are represented between slashes while actual transcriptions are represented between square brackets.

[2] In phonetic transcriptions conventional IPA normalized for Danish is used (Grønnum 2005; Basbøll 2005).

In this phrase a number of segments are lost in the actual pronunciation, i.e. some phonemes are realized as zero, which is typical for spontaneous speech. We can recognize the [uðˀ] in both tiers, and the [x] can be defended as a realization of /k/, but is not obvious whether the [ə] represents /nɒːˀ/ or /du/ or both. The methodological issues involved in this process are discussed in Schachtenhaufen (2013), but in the end this is not a great concern for registration of reductions since regardless of the interpretation of the fine details, both /nɒːˀ/ and /du/ must be considered quite heavily reduced.

This phoneme-to-phone mapping results in a total of 298.512 phoneme-phone pairs (tokens) and 769 types. Each type was judged as to whether it can be considered a distinct or reduced pronunciation. In this judgment traditional lenition hierarchies were applied, e.g. /b/ → [w β 0] are considered as reductions, whereas /b/ → [p] is considered a distinct pronunciation. In this process great care was taken to not regard recent phonological developments in Danish as spontaneous reductions. It is well known that certain changes in vowel quality and quantity that can be regarded as reductions in a conservative norm, seem to be the distinct norm by younger speakers.

With this phoneme-to-phone mapping and judgment of distinctiveness it is possible to take any subset of the corpus and count the number of reductions per 100 phonemes as a measure for comparing various factors. More specifically, we can look at the phonological context, i.e. a certain phoneme or certain phonemes occurring in a specific phonological context, etc. Or we can look at the extra-phonological context, i.e. the set of phonemes occurring in specific word classes, syntactical constructions, information structure, etc.

3. Intrinsic (phonological) factors

Some phonological structures invite phonetic reductions more willingly than others, regardless of their functional load (see next section). Since different languages have different phonological patterns, what constitutes reducible or non-reducible elements is obviously language dependent. Nevertheless, the overall principles presented here may be relevant in most languages.

3.1 Segmental factors

Some segments are, it seems, intrinsically more resistant towards reduction than others. Table 1 shows the number of reduced pronunciations per 100 occurrences for 13 Danish consonants. We see a well-ordered hierarchy of distinctiveness where labials > dorsals > coronals, given the same manner of articulation. Likewise we see a hierarchy for manner of articulation, fricatives > nasals > aspirated plosives > approximants > unaspirated plosives, given the same place of articulation.

These hierarchies may be due to general articulatory features, e.g. the lips are more independent of other articulators and therefore articulatory coordination is easier for labials. Or it may be language specific, e.g. Danish has more labial phonemes, and therefore reduction would more likely lead to coinciding phonetic forms, hence greater care is taken in the production of labials.

Table 1. The number of reductions per 100 occurences for 13 Danish consonants. Closed word classes are excluded.

	Labial		Dorsal		Coronal	
Fricative	f	1.2	--	--	s	2.7
Nasal	m	1.3	ŋ	2.4	n	6.6
Aspirated plosive	p	2.6	k	6.2	t	10.9
Approximant	v	3.5	ʁ	8.3	--	--
Unaspirated plosive	b	6.3	g	18.8	d	19.9

It should also be noted that these measures are not independent of other factors mentioned in the following, e.g. in Danish aspirated plosives and labials more frequently occur in onset, where we generally see fewer reductions (see next section). Likewise, consonants in Danish suffixes and small function words – which generally show a high propensity for reduction – consist mainly of coronals. But even when these factors are taken into consideration, different phonemes tend to be more or less resistant towards reduction.

3.2 Phonological context

The phonological context of a phoneme plays a significant role for the propensity for reduction. Furthermore, the position of the segment in the sylla-

ble as well as the position of the syllable in the word is an important factor. The following seem to be the major tendencies:

- Consonants are more likely reduced in intervocalic position rather than between a vowel and a consonant. In intervocalic position the consonants are often assimilated to the surroundings, i.e. they are opened, plosive → fricative → approximant → ∅, and voiceless consonants become voiced.
- Two syllable nuclei with no internuclear consonants are very likely compressed to a single nucleus. This can be applied after an internuclear consonant is elided, e.g. /ˈsgʁæːwð̩/ → [ˈsgʁæːð̩] → [ˈsgʁæð] *skrevet* 'written'.
- Consonants are reduced more frequently and to a greater degree in coda position than in onset position.
- Unstressed syllables are reduced more frequently and to a greater degree than stressed syllables.

4. Extrinsic (extra-phonological) factors

While the phonological factors as the ones mentioned in the preceding section may explain some of the possibilities for where and how reductions occur in spontaneous speech, they certainly cannot explain why the same phonological string is sometimes realized in a reduced manner and sometimes not. From a phonological point of view a word has these same phonemic representations regardless of the pronunciation, and the level of distinctiveness can therefore not be predicted from the phonemic representation alone. The variation can, however, to a large degree be related to variation in extra-phonological parameters such as morphology, grammatical function, syntax and pragmatics.

4.1 Morphology

Morphological boundaries seem to matter, e.g. a word final /d/ is more likely elided if it is a suffix *-t* rather than a part of the stem. Likewise, an interconsonantal consonant is more likely reduced before a morphological boundary, e.g. in /ˈøsd+li / → [ˈøsli] *østlig* 'eastern', than intramorphematic, e.g. /ˈɛgsdʁɑ/ *ekstra* 'extra' were loss of /d/ never occurs.

In a first approach, the word class also seems to matter. In Table 2 the propensity for phonetic reductions for each of the major word classes is shown. The word class information is derived from the PoS-tags provided in the corpus. The R-values show the number of reduced segments pr. 100 phonemes. We see here that especially nouns, numerals and adjectives show fewer reductions, while prepositions, conjunctions, pronouns and articles are more likely reduced phonetically. Overall, this corresponds very well to the traditional division in content words and function words (see Table 2). However, it also demonstrates that the binary division in content and function words can be refined.

Table 2: The number of reduced segments (R) per 100 phonemes in 11 word classes.

Word class	Words	Reduced segments	Distinct segments	Total segments	R
n.	9512	5565	63399	68964	8.1
num.	496	183	2003	2186	8.4
adj.	4346	2467	20788	23255	10.6
prop.n.	1008	795	6618	7413	10.7
interj.	4859	1955	11701	13656	14.3
adv.	12167	9698	36274	45972	21.1
v.	12290	14602	37168	51770	28.2
prep.	7747	8658	17267	25925	33.4
conj.	5205	4875	8287	13162	37.0
pron.	11467	11327	19037	30364	37.3
art.	3273	5398	5597	10995	49.1
Total	72370	65523	228139	293662	28.7

4.2 Grammatical function

While word class at first glance seems important, a more qualitative analysis reveals that that the propensity for phonetic reduction is far more dependent on grammatical function, i.e. constituent role in the sentence, than on word class. DanPASS is not annotated with grammatical function, so no quantitative measures are available at this point. Nevertheless, some general observations will be presented here.

Nouns are typically distinctly pronounced when they function as subject, object or complement in a prepositional phrase. However, as part of adverbial phrases, compound prepositions, and other grammaticalized constructions, nouns are reduced more frequently and to a greater degree, such as in *hele tiden* 'the whole time', *i virkeligheden* 'in reality, actually', *til gengæld* 'in return', *oven i købet* 'even', *i hvert fald* 'in any case', *i øjeblikket* 'at the moment', *ved siden af* 'beside', *i stedet/steden for* 'instead of', *i forhold til* 'compared to', *på størrelse med* 'the size of', *i tvivl om* 'in doubt', etc. For example, *siden* 'the side' is typically fully expanded, [siːðn̩], as subject/object, where it also is used in a more literal sence, but reduced, [siðn], in the complex preposition *ved siden af* 'beside' etc. Nouns referring to specific entities in the conversation invites a distinct pronunciation, e.g. items like *den lilla trekant, vandfaldet, kirkegården* 'the purple triangle, the waterfall, the graveyard' etc. Inversely, words referring to common concepts are more likely reduced, e.g. *centimeter, et lille stykke, samme måde* 'centimetre, a little bit, the same way' etc.

Likewise, adjectives used in attributive and predicative functions are typically fully expanded. However, in adverbial functions or as part of complex adverbials they are more likely reduced, e.g. /ˈfœ̠sd ɒwˈfʁamˀəsd/ → [ˈfœsd ʌ ˈfʁamˀs] *først og fremmest* 'first and foremost'.

Verbs serve many different functions, which is reflected in great variation in the reductional tendencies. Auxiliary verbs are typically heavily reduced, while participles are more distinctly pronounced. Furthermore, when verbs are used in the most literal sense, they are distinctly pronounced, but in figurative senses and grammaticalized constructions they are typically rather reduced, e.g. the verb /gɔːˀ/ *gå* is pronounced [gɔːˀ] when used in the literal sense 'walk', but [gɔ] in non-literal uses and grammaticalized phrases, such as *gå til venstre* 'go left', *gå tilbage* 'return' etc.

4.3 Syntax

The realization of small function words is highly dependent on their syntactic context. The realization of such words can often be divided in two major forms, which we may call a strong and a weak form. For prepositions the weak form is preferred if occurring immediately before the head in a prepositional phrase, e.g. /pɔːˀ iːˀ æːˀ fʁɑːˀ/ → [pɔ i a fʁɑ] *på, i, af, fra* 'on, in, off, from', but otherwise a strong form is preferred. Pronouns and articles

like /dɛnˀ dɛm deɐ̯ˀ/ *den, dem, der* 'that, them, there' are reduced to [dn̩ bm̩ dɐ] immediately after a verb for which they are subject or after a preposition as determiners in noun phrases. Groups of adjacent small function words are often contracted to a single syllable, e.g.:

/de æɐ̯ ed/	→	[ded]	*det er et* 'that is a'
/slɛd egə/	→	[slɛg]	*slet ikke* 'not at all'
/sʌdan nɔːð̩/	→	[snɔðˀ]	*sådan noget* 'something like that'
/syːnəs ʌsə/	→	[sʌs]	*synes også* 'also think'

There are many other similar syntactically dependent pronunciations. Overall, it can be said that the syntactical integration is mirrored in a phonetic integration of the words, i.e. a larger degree of coarticulation, integrated prosody etc.

4.4 New and old information

Where the phonetic realization of small grammatical words is very much dependent on grammatical structure, semantically heavy words are instead more sensitive to informational structure and pragmatic focus. When an object is introduced for the first time in a dialogue it will typically be pronounced very distinctly, sometimes even hyper-distinctly, i.e. with double stress and fortition of consonants etc., e.g. /ˈløːʊpɑːg/ → [ˈløːvəˈpɑːkx] *løvepark* 'lion park'. When the word is used to refer to an item already mentioned, it is more prone to phonetic reduction. Especially in the case where the word is repeated shortly afterwards in a pronominal function, it can be drastically reduced, e.g. /ˈjæɐ̯nbæːnəʊwɐsgæɐ̯ˀeŋŋ̩/ → [jæɐ̯nbænʌsgɛŋˀ] *jernbaneoverskæringen* 'the railroad crossing'.

These are just some of the linguistic factors that seems to be connected with the propensity for phonetic reductions. One can easily think of other, e.g. semantic or pragmatic, factors that might be relevant (see Heegård 2013). The above mentioned factors serve to illustrate the importance of including linguistic function in investigating phonetic behavior.

5. Summary and discussion

In the previous sections it is demonstrated that the phonetic behavior of a phonological string is dependent on many levels of linguistic abstraction. We can divide these factors into two major categories. Some factors can be labeled as *intrinsic* factors, i.e. factors that have to do with the phonological form of the item, while others are *extrinsic* factors, i.e. factors that have to do with the meaning of the item. It should be noted that these factors may work in opposite directions for a given item. A functionally loaded word may be reduced due to intrinsic factors, e.g. the lack of segmental contrast between phonemes in a word such as /ˈɶːɐðɑmm̩nə/ → [ɶ̜ðɑmnə] *ør-reddammene* 'the trout ponds'. Conversely, a highly grammatical word such as /ˈɛfdɐ/ *efter* 'after' is almost never reduced, which can be explained with reference to the lack of easily reducible elements. Since various intrinsic and extrinsic factors contribute to the phonetic behavior, the investigation of phonetic reductions becomes a highly complex and interdisciplinary task. Furthermore, in this paper we have not even begun to mention the various extralinguistic factors, such as sociolinguistic factors, communication situation, etc., that further complicate the matter. Such factors have only been investigated sporadically in international literature.

However, quite often the various linguistic levels of abstractions all point in the same direction. In Table 3 some traits at various linguistic levels of abstraction have been divided into traits labeled as *heavy* or *light*. As Basbøll (2005: 517-523) observes, if a word has a light trait at one level of abstraction, it will most typically be light in all other dimensions as well. On the basis of this division in heavy and light traits we propose that *the more light traits present in an item, the greater the propensity for phonetic reductions*. This relationship between reducibility and the various linguistic factors furthermore stresses the functionality of phonetic reductions. As demonstrated in the examples in the preceding section, via reduction it is signaled whether a word in a conversation belongs to one or the other category. A distinct pronunciation signals pragmatic focus, literal sense etc., whereas a reduced pronunciation signals backgrounded information, or a grammaticalized construction of some sort, etc. The pragmatic focus of an utterance is emphasized by both a distinct pronunciation of the word in focus as well as phonetic reduction of the defocused surroundings. Whenever a word is decategorized, i.e. moved from i.e. an adjectival function to an

adverbial function, it seems that pressure is put on that word towards phonotactic and prosodic simplification, etc. Finally, the phonetic integration of adjacent items, or the lack thereof, may signal whether these items belong to the same grammatical phrase or not, and thus assist the syntactical parsing of an utterance which would otherwise be ambiguous.

Table 3: A division in heavy and light traits at various levels of linguistic abstraction. (A linguistic elements will typically be either light in most dimensions or heavy in most dimensions.)

Heavy traits	Light traits
phonotactically complex	phonotactically simple
prosodically complex	prosodically simple
morphologically complex	morphologically simple
open word class	closed word class
syntactically unpredictable	syntactically predictable
semantically loaded	semantically light
concrete, literal meaning	abstract/grammatical meaning
pragmatically focused	pragmatically defocused
(low frequency)	(high frequency)

5.1 Frequency effects vs. function

In Table 3 word frequency is put in parenthesis. This is meant to signal that frequency is not considered a linguistic trait on par with the other traits, but rather an indirect consequence of the heavy or light trait. In recent years several investigations of phonetic reductions have focused on connecting the propensity for reduction with word frequency or probability effects (e.g. Jurafsky & al. 2002; Pluymaekers & al. 2005). The inclusion of word frequency in Table 3 serves to point out that such frequency effects cannot easily be separated from the linguistic function. As Hopper & Traugott (2003: 103) states "the more frequently a form occurs in texts, the more grammatical it is assumed to be. Frequency demonstrates a kind of generalization in use patterns". It can thus be argued that statistically significant effects of word frequency is simply a consequence of grammaticalization,

and it is the functional lightness of an item that leads to reduction, whereas word frequency is simply a secondary, statistical consequence of this. In addition, proponents for frequency effects fail to explain why the same item (which logically must have roughly the same frequency of occurrence in any case) varies between expanded and reduced pronunciations. In most cases this variation can be explained with reference to linguistic factors and function. Even though there is a statistical connection between frequency and heaviness, there are counterexamples. According to DanPASS the phonological word /dɛnˀ/ *den* 'that, the' is much more common but less reduced as a pronoun (1324 occurrences, R = 23.4) than as an article (616 occurrences, R = 40.5). Likewise /vɛnsdʁɐ/ *venstre* 'left' is more common but less reduced as a noun (294 occurences, R = 4.0) than as an adjective in the adverbial phrase *på venstre hånd* 'on the left hand side' (264 occurences, R = 7.3), etc. Such examples contradict frequency effects, and they cannot be explained by phonological differences either. However, they *can* be explained with reference to differences in linguistic function.

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